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		Design Agent									
1,2	1	Cog.Eng. J.H. Baldwin	John Baldwin	9/4/96							
1,2	1	Cog. Mgr. J.G. Kristofzski	John Krist	9-4-96							
		QA									
		Safety									
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Tank Characterization Report for Single-Shell Tank 241-U-109

John H. Baldwin
Westinghouse Hanford Company, Richland, WA 99352
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Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in tank 241-U-109. This report supports the requirements of Tri-Party Agreement Milestone M-44-09.

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Tank Characterization Report for Single-Shell Tank 241-U-109

J. H. Baldwin
Westinghouse Hanford Company

R. H. Stephens
Los Alamos Technical Associates

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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Westinghouse Hanford Company P.O Box 1970 Richland, Washington

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U.S. Department of Energy under Contract DE-AC06-87RL10930

EXECUTIVE SUMMARY

This characterization report summarizes the available information on the historical uses, current status, and sampling and analysis results of waste contained in underground storage tank 241-U-109. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order*, Milestone M-44-09 (Ecology et al. 1996).

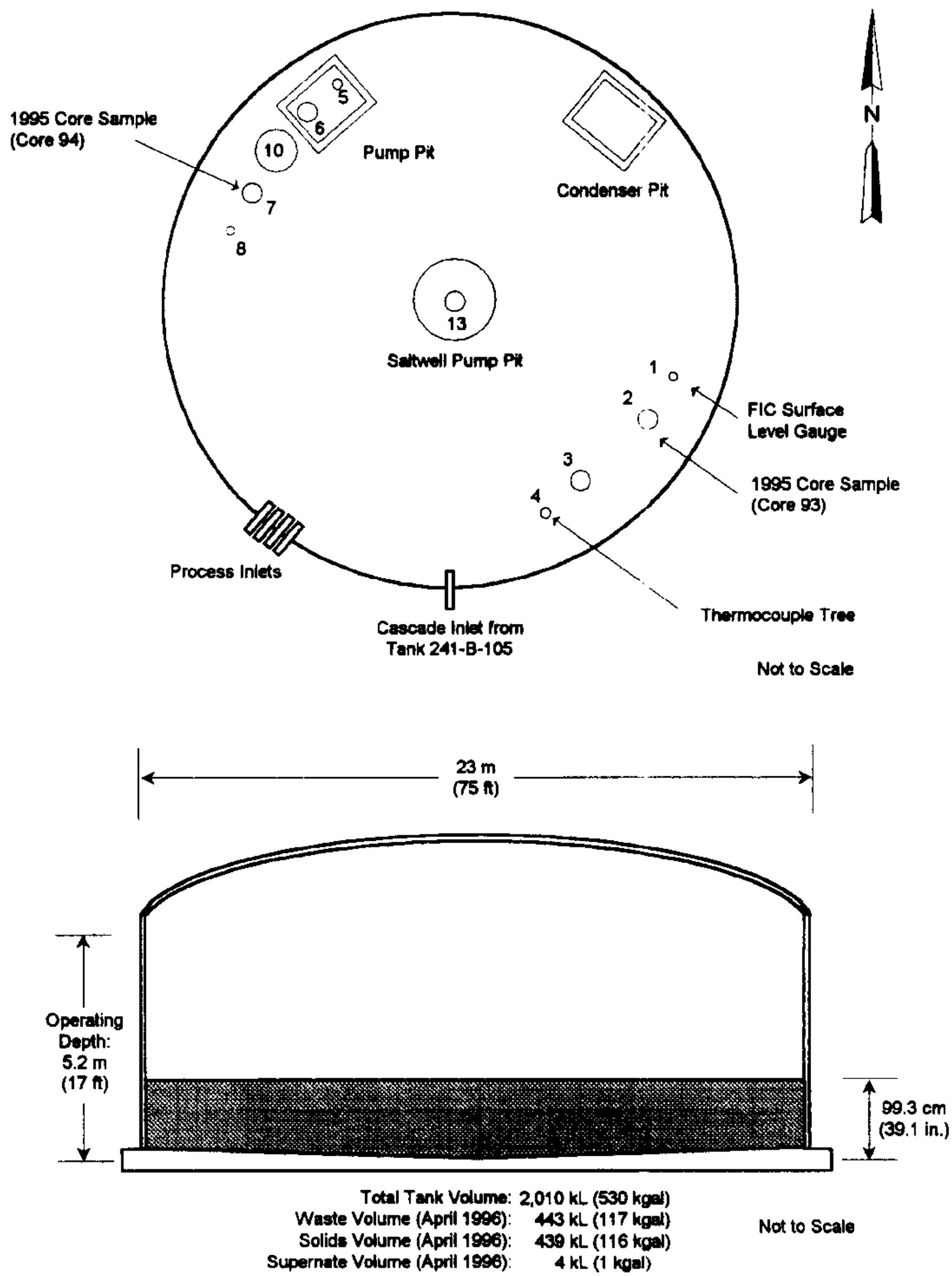
Tank 241-U-109 is one of 12 single-shell tanks located in the Hanford Site 200 West Area U Tank Farm. It is the third in a cascade series of three tanks beginning with tanks 241-U-107 and -108. Tank 241-U-109 went into service in March 1949 by receiving metal waste from the bismuth phosphate process, and was full by the third quarter of 1949. Most of this waste was removed by the second quarter of 1955 as part of uranium recovery operations, leaving only a heel. In the last two quarters of 1956, reduction-oxidation (REDOX) supernatant waste was received. Additional transfers of supernatant waste into and out of the tank occurred over the next several years. In the last quarter of 1975, tank 241-U-109 received 242-S Evaporator bottoms waste. Between the first quarter of 1976 and the second quarter of 1977, residual liquor was both received and pumped out of the tank. Tank 241-U-109 was deactivated in March 1978 and partially interim-isolated in December 1982.

A description of tank 241-U-109 and its status are presented in Table ES-1, and a plan view schematic and profile are provided in Figure ES-1. The tank has an operating capacity of 2,010 kL (530 kgal), and presently contains an estimated 1,753 kL (463 kgal) of non-complexed waste. Of this total volume, 72 kL (19 kgal) are estimated to be supernatant, 182 kL (48 kgal) are estimated to be sludge, and 1,499 kL (396 kgal) are predicted to be saltcake. The sludge and saltcake contain an estimated 617 kL (163 kgal) of drainable interstitial liquid (Hanlon 1996).

Table ES-1. Description and Status of Tank 241-U-109.

TANK DESCRIPTION	
Type	Single-shell
Constructed	1943-1944
In-service	March 1949
Diameter	22.9 m (75.0 ft)
Operating depth	5.2 m (17 ft)
Capacity	2,010 kL (530 kgal)
Bottom shape	Dish
Ventilation	Passive
TANK STATUS	
Waste classification	Non-complexed
Total waste volume	1,753 kL (463 kgal)
Sludge volume	182 kL (48 kgal)
Saltcake volume	1,499 kL (396 kgal)
Supernatant volume	72 kL (19 kgal)
Waste surface level (June 23, 1996)	449 cm (176.7 in.)
Temperature (July 1987 to June 1996)	15.8 °C (60.5 °F) to 36 °C (96 °F)
Integrity	Sound
Watch List	Flammable gases
SAMPLING DATES	
Vapor sampling	August 1995
Push mode core samples and tank headspace flammability	December 1995 to January 1996
SERVICE STATUS	
Deactivated	March 1978
Partially interim isolated	December 1982

Figure ES-1. Profile of Tank 241-U-109.



This report summarizes the collection and analysis of three push mode core samples using a rotary core truck, which were acquired in December 1995 and January 1996, and reported in the *Final Report for Tank 241-U-109, Rotary and Push Mode Cores 123, 124, and 128* (Baldwin 1996a). Cores 123, 124, and 128 were obtained from risers 2, 19, and 7, respectively. The sampling event was performed to satisfy the requirements listed in the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), the *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al. 1995), the *Test Plan for Samples From Hanford Waste Tanks 241-BY-103, BY-104, BY-105, BY-106, BY-108, BY-110, TY-103, U-105, U-107, U-108, and U-109* (Meacham 1995), and the *Historical Model Evaluation Data Requirements* (Simpson and McCain 1995). The sampling and analyses were performed in accordance with the *Tank 241-U-109 Push Core Sampling and Analysis Plan* (Baldwin 1996b). This report also summarizes the results from the August 1995 vapor sampling event. The headspace gas and vapor samples were collected and analyzed to satisfy *Data Quality Objectives for Generic In-Tank Health and Safety Vapors Resolution* (Osborne et al. 1995).

The safety screening data quality objective (DQO) requires analyses for fuel content using differential scanning calorimetry (DSC), weight percent water by thermogravimetric analysis (TGA), total alpha activity through alpha proportional counting, and bulk density measurement by centrifugation. The safety screening DQO also requires a determination of the flammability of the tank headspace gases. To satisfy this requirement, vapor samples were taken before core sampling, and the flammability was measured as a percentage of the lower flammability limit (LFL) using a combustible gas meter. The organic complexant safety DQO and the organic safety test plan also require analyses for fuel content and weight percent water, as well as analyses for total organic carbon (TOC) to evaluate its contribution to the total fuel content. The historical model evaluation DQO requires analyses for several analytes, including the key analytes sodium, aluminum, chromium, carbonate, nitrate, and weight percent water. Finally, the headspace vapor samples were collected and analyzed to characterize the vapors present in the tank headspace and to support safety evaluations and tank farm operations.

To evaluate tank safety, comparisons were made between the analytical results and the decision criteria thresholds defined in the safety screening and organic complexant safety DQOs, and the organic safety test plan. All results given below for DSC and TOC are on a dry weight basis. No exothermic reactions with a change in enthalpy greater than 301.9 J/g were observed in any of the samples, as compared with the safety screening and organic complexant safety DQO decision criteria threshold of 480 J/g, and the organic safety test plan decision threshold of 1,200 J/g. Although one of the one-sided 95 percent confidence interval on the mean upper limits was 493.4 J/g, this was attributed to variability in the data (Baldwin 1996a). All TOC results were below the decision thresholds of 30,000 μg C/g for the organic complexant safety DQO and 45,000 μg C/g for the organic safety test plan. The overall mean result was 4,720 μg C/g, the highest segment sample mean was 15,400 μg C/g, and the largest upper limit to one-sided 95 percent confidence interval on the mean was 18,600 μg C/g. All total alpha activity values were at least two orders of magnitude below their safety screening thresholds. The highest sample mean for total alpha activity was 0.150 μCi/g, the overall mean was 0.0371 μCi/g, and the largest 95 percent confidence interval upper limit was 0.156 μCi/g. Finally, although tank 241-U-109 is on the Flammable Gas Watch List, the concentration of flammable gases in the tank headspace was measured at a maximum of 5 percent of the LFL, well below the decision threshold of 25 percent of the LFL.

The estimated tank heat load based on the analytical results of ^{137}Cs and $^{89/90}Sr$ was 1,880 W (6,420 Btu/hr). Additional predictions include the Historical Tank Content Estimate (HTCE) of 4,120 W (14,100 Btu/hr), and the estimate by Kummerer (1994) of 1,720 W (5,865 Btu/hr). All three estimates were below the 11,700 W (40,000 Btu/hr) high-heat threshold (Bergmann 1991). The most recent tank temperature information available indicated that between July 1987 and June 1996, the mean temperature was 26.8 °C (80.3 °F), with a minimum of 15.8 °C (60.5 °F), and a maximum of 36 °C (96 °F). Since the tank exhibits an upper temperature limit, it is concluded that any heat generated from radioactive sources throughout the year is dissipated.

Based on the comparison of the analytical results to the decision criteria thresholds of the safety screening and organic complexant safety DQOs and the organic safety test plan, the tank is considered safe.

The historical model evaluation DQO (Simpson and McCain 1995) attempts to verify the presence of a particular waste type by identifying several key analytes in the tank waste and then comparing their concentrations to predicted levels. Two waste types were expected to be present in tank 241-U-109 in substantial quantities: SMMS2 saltslurry and SMMS1 saltcake. The results of this comparison indicated that the key analytes met the criterion of $\geq$ 10 percent of the concentration level predicted in the historical DQO. The results indicate that the predicted waste types are present.

Hydrostatic head fluid (HHF) was used during the core sampling operations. Evaluation of the tracer indicated significant contamination (over 50 percent) occurred in segment 3 of core 124. Thus, all drainable liquid data and the solids weight percent water result from this segment were considered unusable and were not factored into calculation of the overall tank means, or used in any other evaluations. Intrusion by HHF was also noted in segment 5 of core 128. However, because this intrusion was not considered significant and the weight percent water data were corrected, the data were used for this segment.

A number of observations can be made concerning this tank.

1. Although tank 241-U-109 is on the Flammable Gas Watch List, the flammable gas concentration in the headspace is well below the threshold and is not a cause for concern.

2. The metal waste heel has a level of uranium that exceeds the value predicted from the transfer history.

3. The aluminum in the waste is mostly soluble in water. This agrees with the process history.

Table ES-2 provides concentration and inventory estimates for the most prevalent analytes, based on the 1995/1996 core sampling analyses.

Table ES-2. Chemical Data Summary for Tank 241-U-109.[1]

Analyte	Overall Mean	RSD (Mean)	Projected Inventory[2]
METALS	**μg/g**	**%**	**kg**
Aluminum	19,700	32.6	57,700
Chromium	3,690	14.1	10,800
Sodium	2.21E+05	3.0	6.47E+05
ANIONS	**μg/g**	**%**	**kg**
Nitrate	3.08E+05	12.8	9.02E+05
RADIONUCLIDES	**μCi/g**	**%**	**Ci**
Total alpha	0.0371	20.9	109
Total beta	126	12.1	3.69E+05
^{137}Cs	112	9.8	3.28E+05
^{90}Sr	6.89	15.4	20,200
CARBON	**μg C/g**	**%**	**kg C**
Total inorganic carbon	7,550	12.0	22,100
Total organic carbon	3,600	7.8	10,500
PHYSICAL PROPERTIES		**%**	**kg**
Weight percent water	23.7	13.6	6.94E+05
Density (g/mL)	1.67	1.6	n/a

Notes:

n/a = not applicable

[1](Baldwin 1996a)

[2]The projected inventory is based on an estimated waste volume of 1,753 kL (463 kgal) (Hanlon 1996) and a density of 1.67 g/mL.

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LIST OF TERMS

ANOVA	analysis of variance
Btu/hr	British thermal units per hour
Ci	curies
Ci/L	curies per liter
cm	centimeters
CWR1	REDOX cladding waste
DL	drainable liquid
DQO	data quality objective
DSC	differential scanning calorimetry
ft	feet
g	grams
g/mL	grams per milliliter
GEA	gamma energy analysis
HDW	Hanford Defined Waste
HHF	hydrostatic head fluid
HTCE	Historical Tank Content Estimate
in.	inches
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
J/g	joules per gram
kg	kilograms
kg C	kilograms of carbon
kgal	kilogallons
kL	kiloliters
LFL	lower flammability limit
m	meters
M	moles per liter
MW	metal waste
mR/hr	milliroentgens per hour
PNNL	Pacific Northwest National Laboratory
REDOX	reduction-oxidation
QA	quality assurance
QC	quality control
RPD	relative percent difference
RSD	relative standard deviation
SACS	Surveillance Analysis Computer System
SAP	sampling and analysis plan
SHMS	Standard Hydrogen Monitoring System
SMMS1	saltcake
SMMS2	saltslurry
TC	thermocouple
TGA	thermogravimetric analysis

LIST OF TERMS (Continued)

TIC	total inorganic carbon
TLM	Tank Layer Model
TOC	total organic carbon
W	watts
WHC	Westinghouse Hanford Company
WSTRS	Waste Status and Transaction Record Summary
wt%	weight percent
°C	degrees Celsius
°F	degrees Fahrenheit
μg C/g	micrograms carbon per gram
μg C/mL	micrograms carbon per milliliter
μCi/g	microcuries per gram
μCi/L	microcuries per liter
μCi/mL	microcuries per milliliter
μg/g	micrograms per gram
μg/mL	micrograms per milliliter
ΔH	enthalpy change

1.0 INTRODUCTION

This tank characterization report presents an overview of single-shell tank 241-U-109 and its waste contents. It provides estimated concentrations and inventories for the waste components based on the latest sampling and analysis activities, in combination with background tank information. The characterization of tank 241-U-109 is based on the results of three push-mode core samples using a rotary core truck, taken in December 1995 and January 1996. The sampling and analysis event was performed to support the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al.1995), *Historical Model Evaluation Data Requirements* (Simpson and McCain 1995), *Data Quality Objectives for Generic In-Tank Health and Safety Vapors Resolution* (Osborne et al. 1995), and the *Test Plan for Samples From Hanford Waste Tanks 241-BY-103, BY-104, BY-105, BY-106, BY-108, BY-110, TY-103, U-105, U-107, U-108, and U-109* (Meacham 1995). The integrated requirements for analyses and decision criteria thresholds for the three DQOs and the test plan can be found in *Tank 241-U-109 Push Core Sampling and Analysis Plan* (Baldwin 1996b).

Tank 241-U-109 was removed from service in 1978 and partially interim-isolated in 1982. Consequently, the composition of the waste should not change appreciably until pretreatment and retrieval activities commence. The analyte concentrations reported in this document reflect the best available estimates of the current tank contents based on the analytical data and historical models. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order*, Milestone M-44-09 (Ecology et al. 1996).

1.1 PURPOSE

The purpose of this report is to summarize the information about the use and contents of tank 241-U-109. Where possible, this information will be used to assess issues associated with safety, operations, environmental, and process development activities. This report also serves as a reference point for more detailed information concerning tank 241-U-109.

1.2 SCOPE

In accordance with the requirements specified in Baldwin (1996b), the following analyses were performed: DSC to evaluate fuel level and energetics; TGA to determine moisture content; total alpha activity analysis to evaluate criticality potential; inductively coupled plasma spectroscopy (ICP) for lithium, aluminum, chromium, sodium, and other selected metals; ion chromatography (IC) for bromide, nitrate, and other selected anions; persulfate and acid coulometry for TOC and total inorganic carbon (TIC); gamma energy analysis (GEA) for ^{137}Cs; uranium by laser fluorimetry; total beta; total alpha activity; $^{89/90}Sr$; and bulk density. In addition to these analyses conducted on the core samples, the tank headspace was sampled for the presence of flammable gases in accordance with the safety screening DQO. This was especially important for tank 241-U-109 because it is on the Flammable Gas Watch List.

Prior to the sampling event discussed in this report, vapor samples were taken from the headspace of tank 241-U-109. These samples were analyzed for permanent gases using gas chromatography/thermal conductivity detection, for total non-methane hydrocarbons using cryogenic preconcentration followed by gas chromatography/flame ionization detection, and for volatile organic analytes using cryogenic preconcentration followed by gas chromatography/mass spectrometry.

2.0 HISTORICAL TANK INFORMATION

This section describes tank 241-U-109 based on historical information. The first part details the current condition of the tank. This is followed by discussions of the tank design, transfer history, and process sources that contributed to the tank waste, including an estimate of the current contents based on the process history. Events that may be related to tank safety issues, such as potentially hazardous tank contents or off-normal operating temperatures, are included. The final part summarizes available surveillance data for the tank. Solid and liquid level data are used to determine tank integrity (leaks) and to provide clues to internal activity in the solid layers of the tank. Temperature data are provided to evaluate the heat generating characteristics of the waste.

2.1 TANK STATUS

As of March 31, 1996, tank 241-U-109 contained an estimated 1,753 kL (463 kgal) of waste classified as non-complexed (Hanlon 1996). Liquid and solid waste volumes are estimated using a level measurement gauge. The solid waste volume was last updated on November 13, 1977. The amounts of various waste phases in the tank are presented in Table 2-1.

Table 2-1. Estimated Tank Contents.

Waste Form	Estimated Volume[1]	
	kL	kgal
Total waste	1,753	463
Supernatant liquid	72	19
Sludge	182	48
Saltcake	1,499	396
Drainable interstitial liquid	617	163
Drainable liquid remaining	689	182
Pumpable liquid remaining	606	160

Note:

[1]For definitions and calculation methods, refer to Appendix C of Hanlon (1996).

Tank 241-U-109 is out of service, as are all single-shell tanks, and is categorized as sound. The tank is on the Flammable Gas Watch List. The tank is passively ventilated. All monitoring systems were in compliance with documented standards as of March 31, 1996 (Hanlon 1996).

2.2 TANK DESIGN AND BACKGROUND

The 241-U Tank Farm was constructed during 1943 and 1944 in the 200 West Area. The farm contains twelve 100-series tanks and four 200-series tanks. The 100-series tanks have a capacity of 2,010 kL (530 kgal), a diameter of 22.9 m (75.0 ft), and an operating depth of 5.2 m (17 ft) (Leach and Stahl 1993). Built according to the first-generation design, the 241-U Tank Farm was designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F). A cascade overflow line 7.5 cm (3 in.) in diameter connects 241-U-109 as the third in a cascade series of three tanks, beginning with tanks 241-U-107 and -108. Each tank in the cascade series is set 1 ft lower in elevation from the preceding tank. The cascade overflow height is approximately 4.9 m (16 ft) from the tank bottom and 610 mm (2 ft) below the top of the steel liner.

The tank has a dished bottom with a 1.2 m (4 ft) radius knuckle. Tank 241-U-109 was designed with a primary mild steel liner (ASTM A283 Grade C) and a concrete dome with various risers. The tank is set on a reinforced concrete foundation. The tank and foundation were waterproofed by a coating of tar covered by a three-ply, asphalt-impregnated waterproofing fabric. The waterproofing was protected by welded wire-reinforced gunite. Two coats of primer were sprayed on all exposed interior tank surfaces (Rogers and Daniels 1944). The tank ceiling dome was covered with three applications of magnesium zinc fluorosilicate wash. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the risers in the tank dome. This tank was covered with approximately 2.1 m (7 ft) of overburden.

Tank 241-U-109 has 14 risers according to the drawings and engineering change notices. The risers range in diameter from 10.2 cm (4 in.) to 1.1 m (42 in.). Table 2-2 shows numbers, diameters, and descriptions of the risers and the nozzles. A plan view that depicts the riser configuration is shown as Figure 2-1. Risers 10 and 19, 10.2 cm (4 in.) in diameter, and risers 2 and 7, 30.5 cm (12 in.) in diameter, are available for use (Lipnicki 1995). A tank cross-section showing the approximate waste level, along with a schematic of the tank equipment, is shown in Figure 2-2.

2.3 PROCESS KNOWLEDGE

Section 2.3.1 and Table 2-3 present the major transfers in which tank 241-U-109 received waste. Section 2.3.2 presents an estimate of the tank contents.

Table 2-2. Tank 241-U-109 Risers.[1,2,3]

Riser Number	Diameter (in.)	Description and Comments
1	4	Thermocouple tree [Bench mark CEO-37531 12/11/86]
2	12	Blind flange
3	12	Sluice nozzle, weather covered
4	4	Recirculation line dip legs, weather covered
5	4	Recirculation line dip legs, weather covered
6	12	Sluice nozzle, weather covered
7	12	B-222 observation port
8	4	ENRAF® surface level gauge
9	4	B-436 liquid observation well [Bench mark CEO-37531 12/11/86]
10	4	Breather filter [Standard hydrogen monitor system/breather filter ECN-W369-021 1/23/95]
12	4	Saltwell transfer line from tank 241-U-112 connected
13	12	Distributor jet
18	42	Sludge pump, weather covered
19	4	Sludge measurement port
Nozzle Number	**Diameter (in.)**	**Description and Comments**
N1	3	Spare, capped
N2	3	Spare, capped
N3	3	Spare, capped
N4	3	Spare, capped
N5	3	Inlet overflow from tank 241-U-108

Notes:

[1]Alstad (1993)

[2]Tran (1993)

[3]Vitro Engineering Corp. (1988)

CEO = Change Engineering Order
ECN = Engineering Change Notice
ENRAF® = a registered trademark of ENRAF Corporation, Houston, Texas.

Figure 2-1. Riser Configuration for Tank 241-U-109.

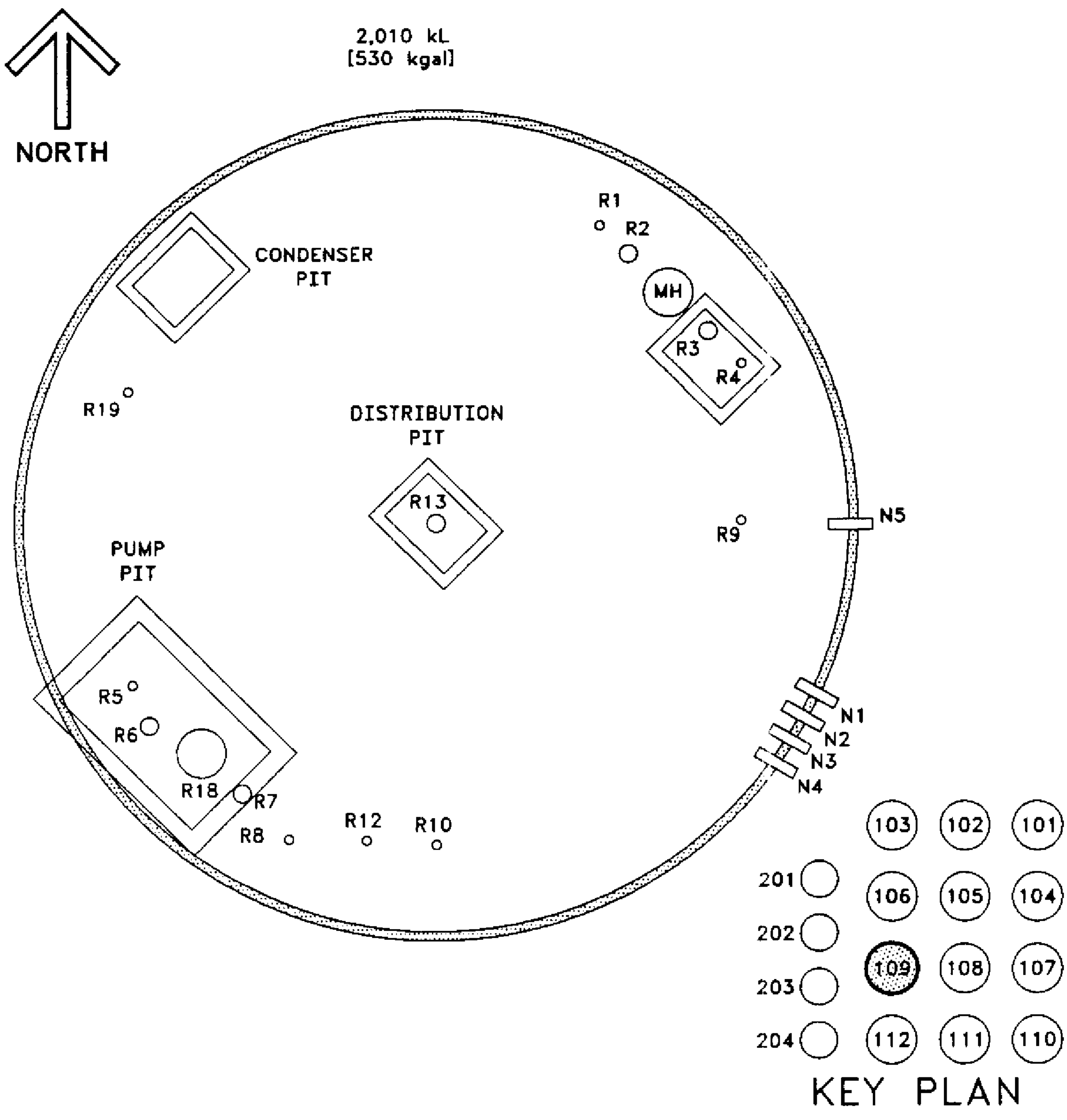
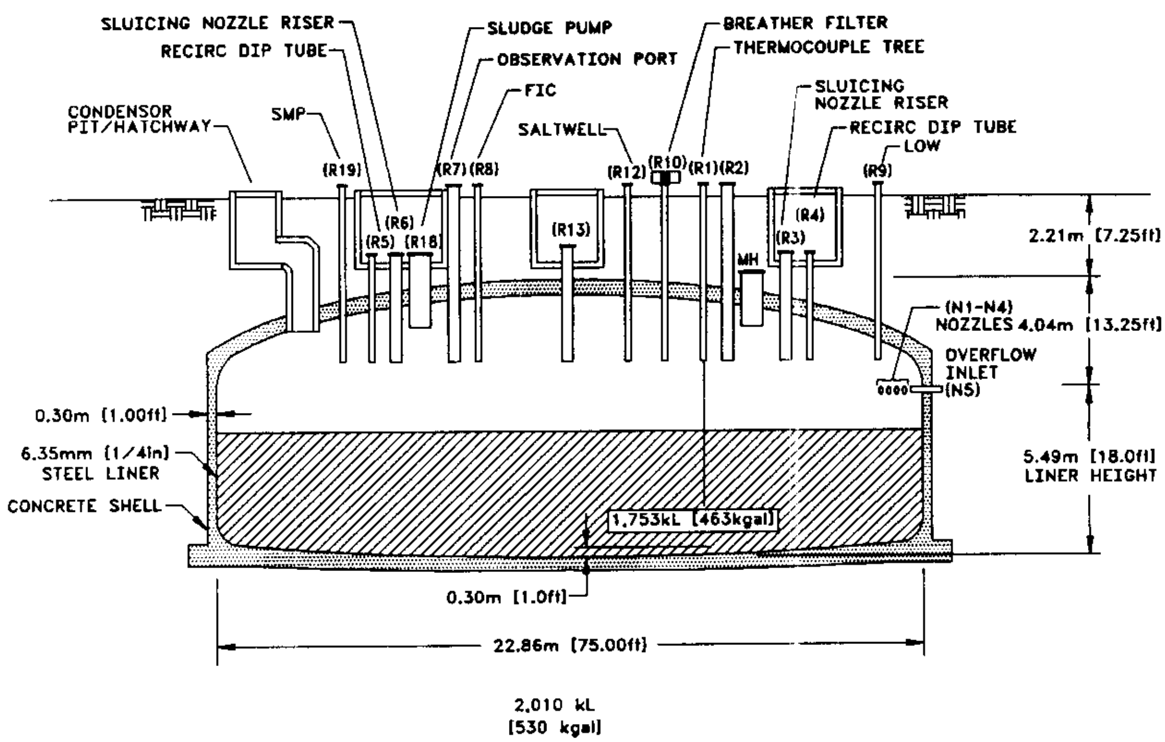


Figure 2-2. Tank 241-U-109 Cross-Section.



2.3.1 Waste Transfer History

Tank 241-U-109 first received metal waste (MW1) from tank 241-U-108 via the cascade line in March 1949, and was full by the third quarter of 1949.

No transfers occurred from the third quarter of 1949 until the second quarter of 1953, when waste began to be removed for uranium recovery. This removal concluded in the third quarter of 1954, at which time 241-U-109 again received metal waste (MW2) cascaded from 241-U-108. The cascade ended in the fourth quarter of 1954. In the first and second quarters of 1955, the waste in tank 241-U-109 was removed for uranium recovery. The heel remaining in the tank was jet-sluiced in the second quarter of 1956.

In the third and fourth quarters of 1956, tank 241-U-109 received REDOX supernate waste from tank 241-U-110. Aside from occasional additions of water from the 241-U-301 catch tank, no transfers occurred until the first and second quarters of 1969, when waste was sent to tank 241-TX-118. In the fourth quarter of 1969, supernate was received from 241-U-107. No further transfers occurred until the first quarter of 1974, when waste was sent to tank 241-S-110.

From the fourth quarter of 1974 until the third quarter of 1975, small amounts of supernate were received from tank 241-U-112. In the fourth quarter of 1975, tank 241-U-109 received 242-S Evaporator bottoms from tank 241-S-102. In the first quarter of 1976 and the second quarter of 1977, residual liquor was sent to tanks 241-S-102 and 241-SY-102, respectively. In the first quarter of 1977, residual liquor was received from tank 241-S-102. Tank 241-U-109 was deactivated in the first quarter of 1978, and partially interim-isolated in 1982.

2.3.2 Historical Estimation of Tank Contents

The following is an estimate of the contents for tank 241-U-109 based on historical transfer data. The historical data used for the estimate are the *Waste Status and Transaction Record Summary for the Southwest Quadrant* (WSTRS) (Agnew et al. 1996b), and the *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3* (Agnew et al. 1996a). The Hanford Defined Waste (HDW) Model Rev. 3 document contains the HDW list, the Tank Layer Model (TLM), and the HTCE. The HTCE predictions have not been validated, and thus should be used with caution.

The WSTRS is a compilation of available waste transfer and volume status data. The HDW provides the assumed typical compositions for Hanford wastes types. In most cases, the available data are incomplete, reducing the reliability of the transfer data and the derived modeling results. The TLM uses the WSTRS data to model the waste deposition processes and, using additional data from the HDW (that may introduce more errors), generates an estimate of the tank contents. Thus, these model predictions are considered estimates that require further evaluation using analytical data.

Table 2-3. Summary of Tank 241-U-109 Waste Received History.[1,2]

Transfer Source	Waste Type Received	Time Period	Estimated Waste Volume	
			kL	kgal
241-U-108 cascade	Metal waste from $BiPO_4$ process	1949	2,006	530
241-U-108 cascade	Metal waste from $BiPO_4$ process	1954	1,688	446
241-U-110	REDOX supernate	1956	1,552	410
241-U-107	Supernate	1969	958	253
241-U-112	Supernate	1974-1975	106	28
241-S-102	Evaporator bottoms	1975	1,332	352
241-S-102	Residual liquor	1977	466	123

Notes:

[1]Waste volumes and types are best estimates based on historical data.

[2]Agnew et al. (Baldwin 1996b)

[3]See Figure 2-4 for complete transfer history.

Based on the TLM, tank 241-U-109 contains four layers of waste, not including the supernate. Listed from last deposit into the tank to the first deposit, these are 685 kL (181 kgal) of SMMS2, 814 kL (215 kgal) of SSMS1, 91 kL (24 kgal) of REDOX cladding waste (CWR1), and 91 kL (24 kgal) of metal waste (MW). A graphical representation of the estimated waste types and volumes for these layers can be seen in Figure 2-3. The waste types in Figure 2-3 in parentheses "( )" are unknowns that are believed to be the indicated waste type.

The MW (bottom waste layer) should contain, from highest concentration above one weight percent, the following major constituents: uranium, hydroxide, sodium, carbonate, and phosphate. Constituents contained in this layer above a tenth of a weight percent are: sulfate, iron, nitrate, and calcium. The CRW1 layer should contain, from highest concentration above one weight percent, the following constituents: hydroxide, aluminum, sodium, nitrite, uranium, nitrate, and lead. Constituents contained in this layer above a tenth of a weight percent are: iron, carbonate, and calcium. The SMMS1 and SMMS2 layers may be difficult to distinguish and have similar inventories. Both SMMS1 and SMMS2 should contain, from highest concentration above one weight percent, the following major constituents: nitrate, sodium, hydroxide, nitrite, aluminum, carbonate, and sulfate. Constituents contained in these waste types above a tenth of a weight percent are: phosphate, chromium and calcium. Table 2-4 presents the historical tank content estimate for tank 241-U-109.

Figure 2-3. Tank Layer Model for Tank 241-U-109.

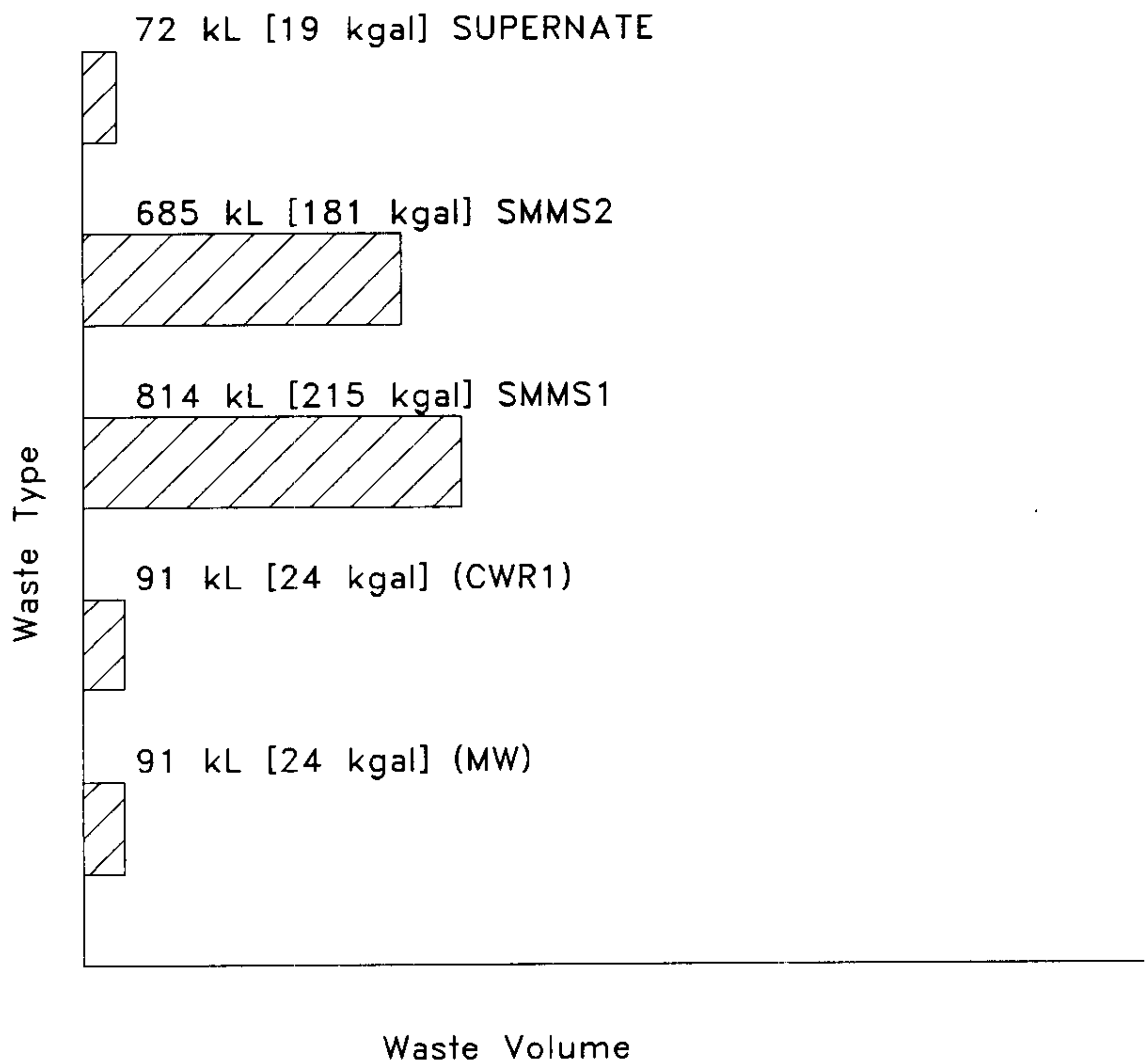


Table 2-4. Tank 241-U-109 Historical Tank Content Estimate.[1,2] (2 sheets)

Total Inventory Estimate			
Physical Properties			
Total solid waste	3.00E+06 kg (463 kgal)		
Heat load	4,120 W (14,100 Btu/hr)		
Bulk density	1.71 (g/mL)		
Water wt%	27.3		
TOC wt% Carbon (wet)	1.02		
Chemical Constituents	M	μg/g	kg[3]
Na^+	14.2	1.91E+05	5.74E+05
Al^{3+}	2.42	38,200	1.15E+05
Fe^{3+} (total Fe)	0.0234	764	2,290
Cr^{3+}	0.0690	2,090	6,290
Bi^{3+}	0.00128	156	468
La^{3+}	3.77E-05	3.05	9.17
Hg^{2+}	2.21E-04	25.9	77.7
Zr (as $ZrO(OH)_2$)	8.76E-04	46.7	140
Pb^{2+}	0.00720	871	2,620
Ni^{2+}	0.00754	258	776
Sr^{2+}	1.26E-05	0.642	1.93
Mn^{4+}	0.00476	153	458
Ca^{2+}	0.0503	1,180	3,530
K^+	0.0641	1,460	4,390
OH^-	10.9	1.08E+05	3.25E+05
NO_3^-	5.87	2.13E+05	6.38E+05
NO_2^-	2.81	75,400	2.26E+05
CO_3^{2-}	0.640	22,400	67,300
PO_4^{3-}	0.122	6,770	20,300
SO_4^{2-}	0.291	16,300	48,900
Si (as SiO_3^{2-})	0.0968	1,590	4,770
F^-	0.0721	800	2,400
Cl^-	0.239	4,940	14,800

Table 2-4. Tank 241-U-109 Historical Tank Content Estimate.[1,2] (2 sheets)

Chemical Constituents	M	μg/g	kg[3]
$Citrate^{3-}$	0.0382	4,213	12,600
$EDTA^{4-}$	0.0226	3,800	11,400
$HEDTA^{3-}$	0.0421	6,730	20,200
$glycolate^{-}$	0.131	5,740	17,200
$acetate^{-}$	0.0101	347	1,040
$oxalate^{2-}$	3.22E-05	1.66	4.97
DBP	0.0239	3,720	11,200
Butanol	0.0239	1,040	3,110
NH_3	0.0652	647	1,940
$Fe(CN)_6^{4-}$	0	0	0
Radiological Constituents	**Ci/L**	**μCi/g**	**Ci[3]**
Pu	---	0.134	6.78 (kg)
U	0.127 (M)	17,700 (μg/g)	53,000 (kg)
Cs	0.286	167	5.01E+05
Sr	0.15	87.7	2.63E+05

Notes:

[1]Agnew et al. (Baldwin 1996a)

[2]The HTCE predictions have not been validated and should be used with caution.

[3]Small differences appear to exist among the inventories in this column and the inventories calculated from the two sets of concentrations. These differences are being evaluated.

2.4 SURVEILLANCE DATA

Tank 241-U-109 surveillance includes surface level measurements (liquid and solid) and temperature monitoring inside the tank (waste and vapor space). The data provide the basis for determining tank integrity.

Liquid level measurements may indicate if there is a major leak from a tank. Solid surface level measurements provide an indication of physical changes and consistency of the solid layers. Tank 241-U-109 has one liquid observation well, in riser 9, used to measure interstitial liquid levels. Four drywells located around the perimeter of the tank monitor change in radiation due to possible waste leakage. None of the drywells show increased radiation levels above background.

2.4.1 Surface Level

The surface level of the waste is monitored with an ENRAF® surface level measurement system through riser 8. The allowable deviations from the tank 241-U-109 baseline of 4.18 m (164.6 in.) are a 7.5 cm (3 in.) increase and a 2.5 cm (1 in.) decrease in two weeks. On June 23, 1996, the surface level from the automatic ENRAF® system was 4.49 m (176.7 in.). On February 6, 1996, the surface level reading from the automatic ENRAF® system increased from 4.17 m (164.3 in.) to 4.48 m (176.4 in.). This exceeded the increase criterion. There was no logical explanation for the increase, and the surface level has remained steady since that time. A graph of the tank volume history is presented in Figure 2-4.

2.4.2 Internal Tank Temperatures

Tank 241-U-109 has a thermocouple (TC) tree located in riser 1, with 11 TCs to monitor the waste temperature. Elevations are available for all TCs. Tank 241-U-109 is on the Flammable Gas Watch List and has a weekly temperature reading requirement. Plots of the individual TC readings can be found in the U Tank Farm supporting document for the HTCE (Brevick et al. 1994).

Temperature data, obtained from the Surveillance Analysis Computer System (SACS) (WHC 1996), were recorded from July 1987 through June 1996. Data were available for all 11 TCs. The mean temperature of the SACS data is 26.8 °C (80.3 °F), with a minimum of 15.8 °C (60.5 °F) and a maximum of 36 °C (96 °F). The mean temperature of the SACS data over the last year (June 1995 through June 1996) is 27.3 °C (81.2 °F), with a minimum of 19 °C (66.2 °F) and a maximum of 31.3 °C (88.3 °F). On June 23, 1996, the low temperature recorded was 22.1 °C (71.78 °F) on TC 10 (located in the vapor space). The high temperature recorded was 29 °C (84.2 °F) on TC 2 (located in the waste). The graph of the weekly high temperatures is provided in Figure 2-5.

Figure 2-4. Tank 241-U-109 Level History.

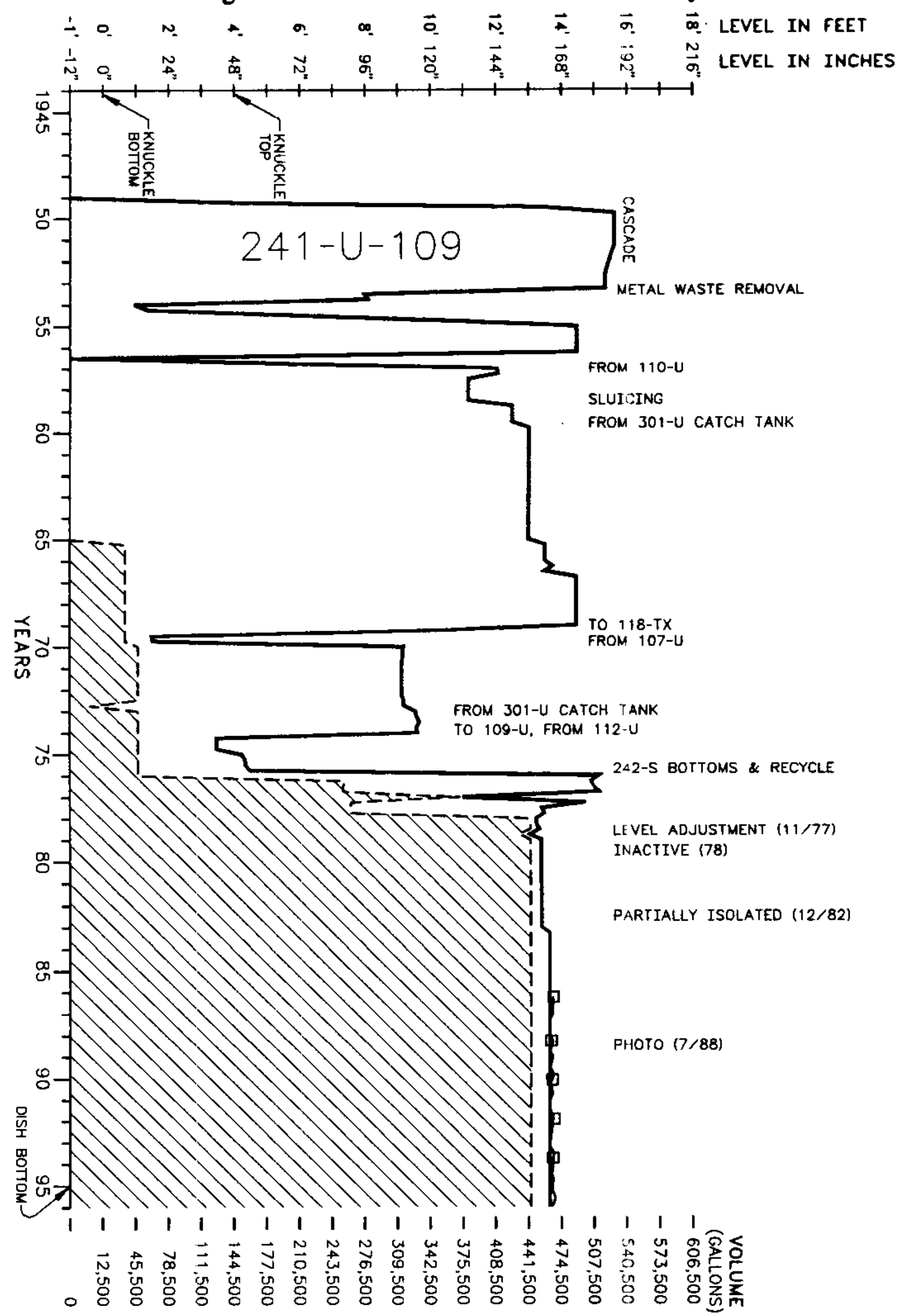
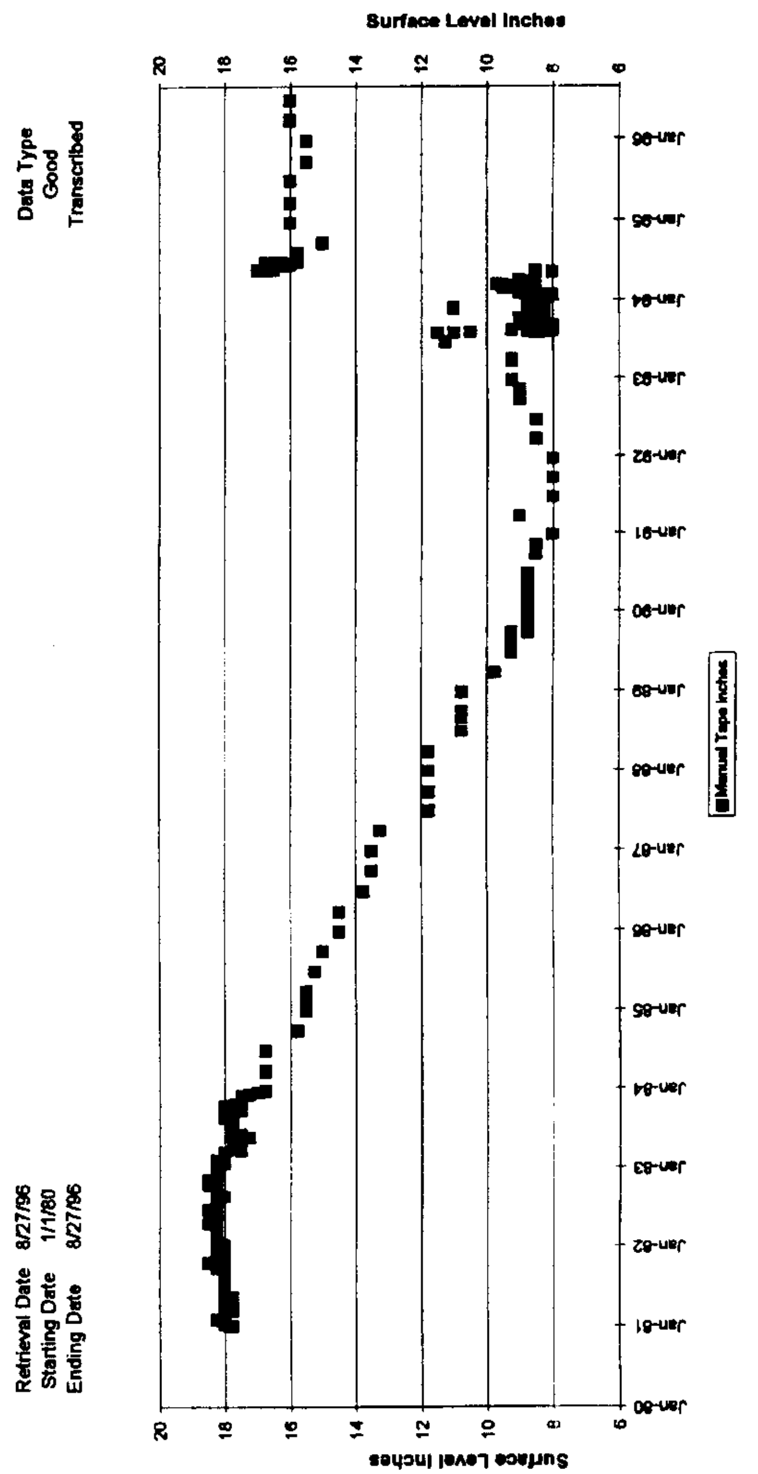


Figure 2-5. Tank 241-U-109 Weekly High Temperature Plot.



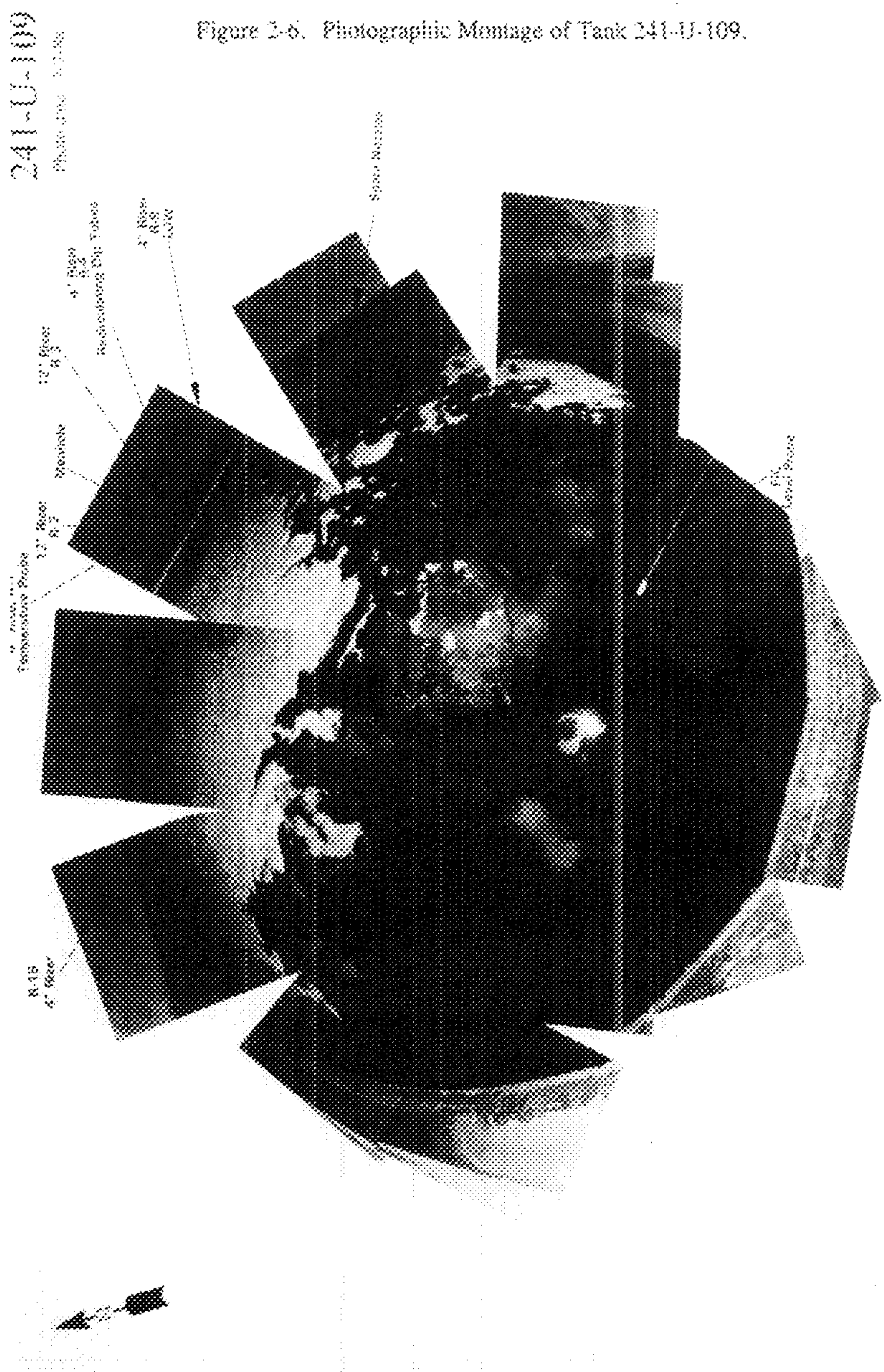
2.4.3 Tank 241-U-109 Photographs

The 1988 photographic montage of the tank 241-U-109 interior shows the waste surface to be a mixture of solids and liquids, with what appears to be an orange-colored saltcake floating on top of the liquid. The volume of waste in the tank, 1,753 kL (463 kgal), has not changed since the photographs were taken; therefore, the photographic montage (Figure 2-6) could still represent the current appearance of the tank waste.

2.5 HYDROGEN GAS MONITORING

Tank 241-U-109 is equipped with standard hydrogen monitoring system (SHMS) cabinets. The SHMS data, vapor grab sample analysis data, and sniff data collected for tank 241-U-109 between July 1995 and February 1996 are reported in Brown (1996).

Figure 2-6. Photographic Montage of Tank 241-U-109.



3.0 TANK SAMPLING OVERVIEW

This section describes the December 1995 and January 1996 sampling and analysis events for tank 241-U-109. Three push-mode core samples using a rotary core truck were taken to satisfy the requirements of the safety screening DQO (Dukelow et al. 1995), the organic complexant safety DQO (Turner et al. 1995), the organic safety test plan (Meacham 1995), and the historical model evaluation DQO (Simpson and McCain 1995). The sampling and analysis were performed in accordance with the sampling and analysis plan (SAP) (Baldwin 1996b). Further discussions of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (DeLorenzo et al. 1994).

Table 3-1 summarizes the sampling mode, applicable DQOs, and sampling and analysis requirements for the 1995/1996 sampling event.

3.1 DESCRIPTION OF SAMPLING EVENT

Three push-mode core samples (using a rotary core truck) were collected from tank 241-U-109 between December 20, 1995 and January 19, 1996. Cores 123, 124, and 128 were obtained from risers 2, 19, and 7, respectively. Water was used to wash the drill string during sampling operations. A tracer (lithium bromide) was added to the wash water to gauge contamination of the segments by the wash water. A field blank and a wash-water HHF blank were also obtained. All samples were received and extruded at the Westinghouse Hanford Company 222-S Laboratory in accordance with the SAP (Baldwin 1996b).

In addition, the tank headspace vapors were measured for flammable gas concentration as required by the safety screening DQO.

3.2 SAMPLE HANDLING

Cores 123, 124, and 128 were received by the Westinghouse Hanford Company 222-S Laboratory between December 21, 1995 and January 22, 1996. These cores were extruded between January 2 and January 26, 1996.

Only segment 3 of core 124 contained drainable liquid (DL). The remaining segments of the three cores were full of saltcake-like solids with slightly different textures. Sample recovery was variable, depending on the particular segment. No separable organic layer was observed in any of the segments. One field blank and one wash-water HHF blank were delivered to the 222-S Laboratory with core 124. All three cores were subsampled at the whole-segment, half-segment, or third-segment level for analysis, depending on the amount of material recovered and the appearance of the extruded segments. Core composites were formed in accordance with the historical model evaluation DQO.

Table 3-1. Integrated Data Quality Objective Requirements for Tank 241-U-109.[1]

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Push-mode core sampling (December 1995/January 1996)	Safety screening (Dukelow et al. 1995)	Core samples from a minimum of two risers separated radially to the maximum extent possible. Flammability taken in tank headspace.	▸ Energetics ▸ Moisture content ▸ Total alpha activity ▸ Bulk density ▸ Headspace gas flammability
	Organic complexant safety (Turner et al. 1995)		▸ Energetics ▸ Moisture content ▸ TOC
	Historical model evaluation (Simpson and McCain 1995)		▸ Energetics ▸ Moisture content ▸ ^{137}Cs ▸ TIC ▸ Metals ▸ Anions ▸ Total alpha activity[2] ▸ Bulk density[2] ▸ TOC[2] ▸ Uranium[2] ▸ Total beta[2] ▸ $^{89/90}Sr$[2]
	Organic safety test plan (Meacham 1995)		▸ Energetics ▸ Moisture content ▸ TOC

Notes:

[1] (Baldwin 1996b)

[2]Secondary requirements.

Table 3-2 presents the subsampling scheme, the amount of sample recovered, the dose rates, and a description of the sample visual characteristics.

Table 3-2. Subsampling Scheme and Sample Description[1]. (4 sheets)

Segment	Sub-segment	Solids extruded (in.)	Total Sample Weight (g)	Dose Rate through Drill String (mR/hr)	Description: Color	Description: Texture
Core 123						
1	Whole	2 to 3	79.3	400	Medium gray	Resembled a fine crystalline saltcake. Lower portion was soft, like wet sand; upper portion was harder and had larger crystals.
2	Whole	10	293.3	700	Medium gray except for the grayish brown bottom inch	Resembled a fine crystalline saltcake. Upper portion appeared drier than lower portion.
3	Upper ½	10	170.9	350	Medium gray with a little green blue tint in the bottom 4 in.	Resembled a fine crystalline saltcake.
	Lower ½	8	169.6	320	Bluish gray	Resembled a damp saltcake.
4	Whole	12	303.0	700	Bluish gray	Resembled a damp saltcake.
5	Whole	4	106.3	400	Bluish gray	Resembled a damp saltcake.
6	Upper ½	19	505.7	1,800	Medium gray	Resembled a damp, putty-like saltcake.
	Lower ½					
7	Upper ½	14	393.6	1,100	Medium gray with a bluish tint	Resembled a damp saltcake.
	Lower ½					
8	Upper ½	16	454.1	1,500	Medium gray with a bluish tint	Resembled a damp saltcake.
	Lower ½					

Table 3-2. Subsampling Scheme and Sample Description[1]. (4 sheets)

Segment	Sub-segment	Solids extruded (in.)	Total Sample Weight (g)	Dose Rate through Drill String (mR/hr)	Description	
					Color	Texture
9	A	16	419.9	1,000	Upper portion was dark gray middle portion was medium gray lower portion was yellow	Resembled a damp saltcake.
	B					
	C					
Core 124						
2	Whole	2	26.6	140	Black with a white/gray tint	Resembled a hard, slightly damp crystalline saltcake.
3	DL	N/A	125 mL	900	Black and opaque	N/A
	Whole	10	372.2		Gray	Resembled a wet, slushy saltcake.
4	Whole	9	246.1	1,000	Gray with a blue tint	Resembled a dry, granular saltcake.
5	Upper ½	18	474.5	1,400	Gray with a white tint	Resembled a damp, smooth saltcake.
	Lower ½					
6	Upper ½	19	477.4	1,700	Medium gray	Resembled a damp, putty-like saltcake.
	Lower ½					
7	Upper ½	17.5	448.0	1,100	Medium gray	Resembled a damp, putty-like saltcake.
	Lower ½					
8	Upper ½	16	445.3	1,100	Medium gray	Resembled a damp, putty-like saltcake.
	Lower ½					

Table 3-2. Subsampling Scheme and Sample Description[1]. (4 sheets)

Segment	Sub-segment	Solids extruded (in.)	Total Sample Weight (g)	Dose Rate through Drill String (mR/hr)	Description	
					Color	Texture
9	Upper ½	12	249.5	700	Black	Resembled a smooth saltcake.
	Lower ½				Gray	Resembled a slightly pitted saltcake.
Field blank	n/a	n/a	---	< 0.5	Clear liquid. No solids. No liner liquid.	
HHF	n/a	n/a	---	< 0.5	N/A	
Core 128						
1	Whole	3	70.4	250	Medium gray	Wet, crumbly saltcake
2	Whole	6	143.9	300	Medium gray with a bluish tint	Resembled a saltcake.
3	Whole	10	216.1	800	Medium gray with a bluish tint	Resembled a damp saltcake.
4	Upper ½	14	314.4	1,500	Dark gray	Resembled a wet saltcake.
	Lower ½					
5	Whole	7	175.0	1,000	Dark gray	Resembled a saltcake.
6	Upper ½	16	381.4	1,000	Dark gray	Resembled a wet saltcake.
	Lower ½					
7	Upper ½	18	403.2	1,000	Dark gray	Resembled a damp saltcake.
	Lower ½					

Table 3-2. Subsampling Scheme and Sample Description[1]. (4 sheets)

Segment	Sub-segment	Solids extruded (in.)	Total Sample Weight (g)	Dose Rate through Drill String (mR/hr)	Description	
					Color	Texture
8	Upper ½	17	439.5	1,200	Dark gray	Resembled a saltcake.
	Lower ½					
9	Whole	9	229.3	500	Ranged from brown to dark gray with white specks mixed throughout.	Resembled a saltcake.

Notes:
DL = Drainable liquid

[1] (Baldwin 1996a)

3.3 SAMPLE ANALYSIS

As noted in Table 3-1, the safety screening DQO required analyses for thermal properties by DSC, moisture by TGA, fissile content by total alpha analysis, and bulk density (specific gravity for the drainable liquid sample). In addition to the core samples, the flammability of the tank headspace was measured before core sampling.

Bromide analysis by IC and lithium analysis by ICP were required by the SAP to determine the amount of HHF contamination in the samples. Nitrate and several metals were also reported as a result of the IC and ICP analyses, in order to satisfy the requirements of the historical model evaluation DQO.

The historical model key analytes were confirmed to be present, and therefore the DQO required secondary analyses on selected subsegments and core composites. These were in addition to the key analytes aluminum, chromium, sodium, nitrate, TIC, and weight percent water, and the other primary analytes DSC and ^{137}Cs. The IC analyses for nitrate were performed on each selected solid subsegment and core composite after preparation by a water leach, as required by the historical model evaluation DQO. For all ICP analyses, the solid subsegments and core composites were prepared using a potassium hydroxide fusion digestion in a zirconium crucible. The drainable liquid sample from segment 3 of core 124 was diluted with acid before ICP analysis. An ICP analysis for aluminum, chromium, and sodium was also performed on a water-leached aliquot from each of the core composite samples, and on the segments that were selected for the secondary historical analyses as most representative of their waste type based on the key analyte analysis (Baldwin 1996a). Additional analytes required by the historical model evaluation DQO included bismuth, calcium, iron, manganese, nickel, phosphorus, silicon, and uranium. Secondary analytes included TOC, total alpha activity, bulk density, total beta, $^{89/90}Sr$, as well as uranium analyzed by laser fluorimetry.

The organic complexant safety DQO and the organic safety test plan also required DSC, TOC, and weight percent water as primary analyses.

Laboratory control checks included, where appropriate, laboratory control standards, matrix spikes, duplicate analyses, and blanks. An assessment of the quality control (QC) procedures and data is presented in Section 5.1.2 of this report.

All reported analyses were performed in accordance with approved laboratory procedures. A list of the sample numbers and applicable analyses is presented in Table 3-3. Table 3-4 displays the analytical procedures by title and number. No deviations or modifications were noted by the laboratory.

Table 3-3. Summary of Samples and Analyses.[1] (6 sheets)

Core	Segment	Segment Portion	Analyses
123	1	Whole	DSC, TGA, TIC, TOC Bulk Density IC ICP (Fusion), Alpha, GEA
	2	Whole	DSC, TGA, TIC, TOC Bulk Density IC ICP (Fusion), Alpha, GEA
	3	Upper ½	DSC, TGA, TIC, TOC Bulk Density IC ICP (Fusion), Alpha, GEA
		Lower ½	DSC, TGA, TIC, TOC Bulk Density IC ICP (Fusion), Alpha, GEA
	4	Whole	DSC, TGA, TIC, TOC Bulk Density IC ICP (Fusion), Alpha, GEA, U, $^{89/90}Sr$, Beta ICP (Acid Digest)
	5	Whole	DSC, TGA, TIC, TOC Bulk Density IC ICP (Fusion), Alpha, GEA
	6	Upper ½	TGA, TIC, TOC Bulk Density IC ICP (Fusion), GEA
		Lower ½	Bulk Density DSC, TGA, TIC, TOC IC ICP (Fusion), Alpha, GEA, Beta, U, $^{89/90}Sr$ ICP (Acid Digest)

Table 3-3. Summary of Samples and Analyses.[1] (6 sheets)

Core	Segment	Segment Portion	Analyses
123	7	Upper ½	TGA, TIC, TOC Bulk Density IC ICP (Fusion), GEA
		Lower ½	Bulk Density TGA, DSC, TIC, TOC IC ICP (Fusion), Alpha, GEA
	8	Upper ½	DSC, TGA, TIC, TOC Bulk Density IC ICP (Fusion), GEA
		Lower ½	Bulk Density TGA, DSC, TIC, TOC IC ICP (Fusion), Alpha, GEA
	9	A	DSC, TGA, TIC, TOC Bulk Density IC ICP (Fusion), GEA
		B	Bulk Density TGA, DSC, TIC, TOC IC ICP (Fusion), GEA
		C	Bulk Density TGA, DSC, TIC, TOC IC ICP (Fusion), GEA, Alpha
	Composite		Bulk Density DSC, TGA, TIC, TOC ICP (Fusion), GEA, Alpha, Beta, U, $^{89/90}Sr$ IC ICP (Acid Digest)

Table 3-3. Summary of Samples and Analyses.[1] (6 sheets)

Core	Segment	Segment Portion	Analyses
124	2	Whole	DSC, TGA, TIC, TOC ICP (Fusion), GEA, Alpha IC
	3	DL	DSC, SpG, TGA, TOC, ICP (Acid Dilution), IC, Alpha
		Whole	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha, Beta, U, $^{89/90}Sr$ ICP (Acid Digest)
	4	Whole	Bulk Density DSC, TGA, TIC, TOC ICP (Fusion), GEA, Alpha IC
	5	Upper ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	6	Upper ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	7	Upper ½	Bulk Density TGA, TIC, TOC ICP (Fusion), GEA, Alpha IC
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC

Table 3-3. Summary of Samples and Analyses.[1] (6 sheets)

Core	Segment	Segment Portion	Analyses
124	8	Upper ½	Bulk Density TGA, TIC, TOC ICP (Fusion), GEA, Alpha, Beta, U, $^{89/90}Sr$ IC ICP (Acid Digest)
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	9	Upper ½	Bulk Density TGA, DSC , TIC, TOC ICP (Fusion), GEA, Alpha IC
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	Field Blank		DSC, SpG, TGA, TOC, ICP (Acid Dilution), IC, Alpha
	HHF		Lithium, IC
	Composite		Bulk Density DSC, TGA, TIC, TOC ICP (Fusion), GEA, Alpha, Beta, U, $^{89/90}Sr$ IC ICP (Acid Digest)
	1	Whole	Bulk Density TGA, DSC , TIC, TOC ICP (Fusion), GEA, Alpha IC
	2	Whole	Bulk Density TGA, DSC TIC, TOC ICP (Fusion), GEA, Alpha, Beta, U, $^{89/90}Sr$ IC ICP (Acid Digest)

Table 3-3. Summary of Samples and Analyses.[1] (6 sheets)

Core	Segment	Segment Portion	Analyses
128	3	Whole	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	4	Upper ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	5	Whole	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	6	Upper ½	Bulk Density TGA, TIC, TOC ICP (Fusion), GEA, Alpha IC
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	7	Upper ½	Bulk Density TGA, TIC, TOC ICP (Fusion), GEA, Alpha, Beta, U, $^{89/90}Sr$ IC ICP (Acid Digest)
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC

Table 3-3. Summary of Samples and Analyses.[1] (6 sheets)

Core	Segment	Segment Portion	Analyses
128	8	Upper ½	Bulk Density TGA, TIC, TOC ICP (Fusion), GEA, Alpha IC
		Lower ½	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	9	Whole	Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha IC
	Composite		Bulk Density TGA, DSC, TIC, TOC ICP (Fusion), GEA, Alpha, Beta, U, Sr IC ICP (Acid Digest)
Vapor Tests	Tank Headspace		Combustible gas meter readings for flammable gas

Notes:

[1] (Baldwin 1996a)

Table 3-4. Analytical Procedures.[1]

Analysis	Instrument	Preparation Procedure	Analytical Procedure
Energetics by DSC	Mettler™ Perkin-Elmer™	N/A	LA-514-113, Rev. C-1 LA-514-114, Rev. C-1
Percent water by TGA	Mettler™ Perkin-Elmer™	N/A	LA-560-112, Rev. B-1 LA-514-114, Rev. C-1
Total alpha activity	Alpha proportional counter	Fusion digest on solid samples, LA-549-141, Rev. E-0 & F-0; Direct on liquid samples	LA-508-101, Rev. D-2
Solid bulk density	N/A	N/A	LO-160-103, Rev. B-0
Liquid specific gravity	N/A	N/A	LA-510-112, Rev. C-3
ICP	Inductively coupled plasma spectrometer	LA-549-141, Rev. F-0 LA-505-159, Rev. D-0	LA-505-151, Rev. D-3
IC	Ion chromatograph	LA-504-101, Revs. D-0, E-0	LA-533-105, Rev. D-1
TIC	Coulometry	N/A	LA-342-100, Rev. C, D
TOC	Direct Persulfate	N/A	LA-342-100, Rev. C, D
^{137}Cs	Gamma detector spectrometer	LA-549-141, Revs. D-0, E-0	LA-548-121, Rev. D-1
$^{89/90}Sr$	Separation and counting	LA-549-141, Revs. D-0, E-0	LA-220-101, Rev. D-0
Total beta	Separation and counting	N/A	LA-508-101, Rev. D-2
Uranium	Laser fluorimetry	LA-549-141, Revs. D-0, E-0	LA-925-009, Rev. A-1
Flammable gas	Combustible gas meter	N/A	WHC-IP-030, IH 1.4 and IH 2.1

Notes:

Mettler™ is a registered trademark of Mettler Electronics, Anaheim, California.

Perkin-Elmer™ is a registered trademark of Perkins Research and Manufacturing Company, Inc., Canoga Park, California.

[1](Baldwin 1996a)

3.5 DESCRIPTION OF THE VAPOR SAMPLING EVENT (1995)

The tank headspace was vapor-sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Vapors Resolution* (Osborne et al. 1995). This DQO directed the collection and analysis of headspace vapor samples to help determine the potential risks of fugitive emissions to tank farm workers. The results have been reported in *Headspace Vapor Characterization of Hanford Waste Tank 241-U-109 Results from Samples Collected on August 10, 1995* (Evans et al. 1996). The summarized results are found in Section 4.2.

3.4 DESCRIPTION OF HISTORICAL SAMPLING EVENT

Before the 1995/1996 sampling, tank 241-U-109 was last sampled in December 1975. Since that time, the tank contents have changed substantially due to waste transfers into and out of the tank (see Section 2.3.1). Therefore, the results from the historical sampling event discussed below are not representative of the current tank contents. The data from this sampling event have been included in this report for information only.

A sample was received on November 12, 1975, and analyzed on December 15, 1975. The sample was noted as consisting of small white crystals intermixed with a coarse gray granular material. A description of the technique or procedure used to obtain the sample, and information concerning the sampled riser or sample depth, were not available (Horton 1975a).

Waste analyses were made by dissolving the sample in water. The sample fraction that was not water-soluble was dissolved in HCl. Solids insoluble in water or HCl were fused with KOH, with the melt then dissolved in concentrated HCl and diluted with water. Analytical results are in Table C-1 of Appendix C for the supernatant liquid, and Table C-2 for the solids. These analytical results were duplicated in an internal budget report published by Horton (1975b).

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4.0 ANALYTICAL RESULTS

Section 4.0 presents a summary of the analytical results for the December 1995 and January 1996 sampling event. The sampling and analysis parameters governing this event were integrated by, and described in, the SAP (Baldwin 1996b). Extrusion and analysis of the core samples were performed at the Westinghouse Hanford Company 222-S Laboratory.

Data locations for this tank characterization report are displayed in Table 4-1.

Table 4-1. Analytical Data Presentation Tables.

Data Type	Tabulated Location
Chemical data summary	Table 4-2
Exothermic DSC data summary	Table 4-3
Comprehensive analytical data	Appendix A
Hydrostatic head fluid contamination check data	Appendix B
1975 historical sampling data	Appendix C

4.1 DATA PRESENTATION

The analytical results from the 1995/1996 sampling of tank 241-U-109 were reported in *Final Report for Tank 241-U-109, Rotary and Push Mode Cores 123, 124, and 128* (Baldwin 1996a) and have been summarized in Section 4.1. Sections 4.1.1, 4.1.2, 4.1.3, and 4.1.4 present the chemical data, the physical data, the headspace flammability results, and the HHF contamination check results, respectively.

4.1.1 Chemical Data Summary

Table 4-2 presents the mean concentration estimates and inventories for the solids results. Data from the three core samples were combined to derive overall means for all analytes except DSC, which does not require calculation of a mean. All information contained in Table 4-2 was taken from the Appendix A tables.

The overall mean presented in Table 4-2 was calculated by first averaging the individual primary and duplicate results for each subsegment to obtain a subsegment mean. The DSC, TGA, TIC, and TOC analyses each had several triplicate runs conducted, and these were averaged into the calculation of the particular subsegment means. The subsegment means within a given segment were then averaged to obtain a segment mean, the segment means within a given core were averaged to obtain a core mean, and finally, the three core means were averaged to derive the overall tank mean. Not all of these steps are necessary for each analyte or for each subsegment, but the procedure to be followed is the same. The overall mean and projected inventories listed in Table 4-2 were considered either detected or nondetected (<) values. When fifty percent or more of the individual primary and duplicate measurements had detected results, the overall mean was reported as a detected value. Conversely, when greater than half of the individual primary and duplicate measurements had nondetected results, the overall mean was reported as a nondetected value. The implication associated with nondetected numbers as quantitative observations results in the mean concentrations and inventory estimates being biased. The magnitude of the bias is unknown.

The third column displays the relative standard deviation (RSD) of the mean, defined as the standard deviation of the mean divided by the mean and multiplied by 100. The RSDs were determined by using standard analysis of variance (ANOVA) statistical techniques (nested models), and were computed only for those analytes that had detected means.

The projected inventories listed in the fourth column were obtained by multiplying the overall mean by the total waste volume of 1,753 kL (463 kgal), the overall tank density of 1.67 g/mL, and the appropriate conversion factors.

Overall tank means and inventories for the drainable liquid sample were not included in Table 4-2 because of HHF contamination. The results are included in the Appendix A tables for information only.

4.1.2 Physical Data Summary

Thermal analyses and density measurements were performed on the tank 241-U-109 core samples to satisfy the requirements of the safety screening DQO (Dukelow et al. 1995). The organic complexant safety DQO (Turner et al. 1995), the organic safety test plan (Meacham 1995) and historical model evaluation DQO (Simpson and McCain 1995) required thermal analyses only.

4.1.2.1 Thermogravimetric Analysis. During a TGA, the mass of a sample is measured while its temperature is increased at a constant rate. Nitrogen is passed over the sample during the heating to remove any released gases. Any decrease in the weight of a sample represents a loss of gaseous matter from the sample either through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (typically 150 °C) is due to water evaporation. TGA was performed on homogenized solid samples and directly on drainable liquids.

Table 4-2. Chemical Data Summary for Tank 241-U-109.[1]

Analyte	Overall Mean	RSD (Mean)	Projected Inventory
METALS	**µg/g**	**%**	**kg**
Aluminum	19,700	32.6	57,700
Bismuth	< 2,110	n/a	< 6,180
Calcium	< 2,110	n/a	< 6,180
Chromium	3,690	14.1	10,800
Iron	< 1,420	n/a	< 4,160
Manganese	< 216	n/a	< 632
Nickel	< 421	n/a	< 1,230
Phosphorus	< 8,000	n/a	< 23,400
Silicon	< 1,150	n/a	< 3,370
Sodium	2.21E+05	3.0	6.47E+05
Uranium	< 10,600	n/a	< 31,000
ANIONS	**µg/g**	**%**	**kg**
Nitrate	3.08E+05	12.8	9.02E+05
RADIONUCLIDES	**µCi/g**	**%**	**Ci**
Total alpha	0.0371	20.9	109
Total beta	126	12.1	3.69E+05
^{137}Cs	112	9.8	3.28E+05
$^{89/90}Sr$	6.89	15.4	20,200
CARBON	**µg C/g**	**%**	**kg C**
Total inorganic carbon	7,550	12.0	22,100
Total organic carbon	3,600	7.8	10,500
PHYSICAL PROPERTIES		**%**	**kg**
Weight percent water	23.7	13.6	6.94E+05
Density (g/mL)	1.67	1.6	n/a

Notes:

n/a = not applicable.

[1] (Baldwin 1996a)

The TGA results for tank 241-U-109 are presented in Appendix A, Table A-25. Again, the weight loss was attributed to the evaporation of water. The overall weight percent water mean estimate for the solids was 27.7 percent. Several of the individual samples were below the organic complexant DQO decision threshold of 17 weight percent water. Because the minimum exothermic energy necessary to support a propagating reaction is a change in enthalpy of 480 J/g (Turner et al. 1995), and because none of the sample results exhibited an exothermic reaction of this magnitude, the low weight percent water values were not a concern.

4.1.2.2 Differential Scanning Calorimetry. During a DSC analysis, heat absorbed or emitted by a substance is measured while the temperature of the substance is increased at a constant rate. While the substance is being heated, nitrogen is passed over the waste material to remove any gases being released. The onset temperature for an endothermic (characterized by or causing the absorption of heat) or an exothermic (characterized by or causing the release of heat) event is determined graphically. The DSC results (wet basis) are presented in Appendix A, Table A-26. The peak temperature and maximum enthalpy changes are given for each sample.

Table 4-3 lists all of the samples that had one or more exothermic reactions recorded. As can be seen, none of the samples exceeded the safety screening and organic complexant safety DQO decision threshold of 480 J/g, or the organic safety test plan decision threshold of 1,200 J/g. The highest individual sample result was 301.9 J/g (dry weight). The highest one-sided 95 percent confidence interval upper limit on the mean was 493.4 J/g (dry weight), slightly above the safety screening and organic complexant safety DQO decision threshold. However, this result was attributed to variability in the data (Baldwin 1996a).

4.1.2.3 Density. Density measurements were performed on all solids subsegments. The subsegment level results ranged from a high of 1.97 g/mL from quarter segment C of segment 9, core 123, to a low of 1.24 g/mL from the upper half of segment 3, core 123. The average density for the tank was 1.67 g/mL. This compares with a composite average of 1.75 g/mL. The results are presented in Appendix A, Table A-27.

4.1.3 Headspace Flammability Screening Results

As required by the safety screening DQO (Dukelow et al. 1995) and requested in the SAP (Baldwin 1996b), the tank headspace was sampled and analyzed for the presence of flammable gases before core sampling. This was especially crucial considering that tank 241-U-109 is on the Flammable Gas Watch List. The analytical results showed a maximum of 5 percent of the LFL, well below the 25 percent decision threshold.

Table 4-3. Exothermic DSC Results and 95 Percent Confidence Interval Upper Limits.

Core: Segment	Sub Segment	Run	Wet Wt. Δ H J/g	Sample Wt % Water %	Dry Wt. Δ H[1] J/g	Dry Wt. Mean J/g	95 % Confidence Interval Upper Limits (Dry Wt.) J/g
123:6	Lower ½	1	68.70	31.98	101	103	147.2
		2	88.50		130.1		
		3	52.90		77.8		
123:9	A	1	19.00	37.67	30.5	43.9	128.5
		2	35.70		57.3		
124:5	Lower ½	1	215	21.41	273.6	287.8	377.1
		2	237.3		301.9		
124:6	Upper ½	1	180	28.81	252.7	261.4	316
		2	192.2		270		
124:6	Lower ½	1	90.30	35.98	141.1	146.4	179.9
		2	97.10		151.7		
128:1	Whole	1	0	30.01	0	17.3	43.8
		2	14.80		21.2		
		3	21.50		30.8		
128:4	Lower ½	1	142.6	46.71	267.6	225.1	493.4
		2	97.30		182.6		
128:5	Whole	1	8.900	27.62	13.70	17.5	41.3
		2	13.80		21.24		
128:6	Lower ½	1	74.30	33.31	111.4	113.8	128.6
		2	77.40		116.1		
128:7	Lower ½	1	77.90	40.57	131.1	132.8	143.2
		2	79.90		134.4		
128:8	Lower ½	1	0	31.02	0	60.8	156.4
		2	77.40		112.2		
		3	48.50		70.3		

Notes:

[1]The dry weight results in column seven are calculated by using the wet weight results in column five and the weight percent water results in column six, according to the following equation:

$$\frac{\text{J/g (wet weight)}}{1-\text{(weight percent water/100)}} = \text{J/g dry weight.}$$

4.1.4 Hydrostatic Head Fluid Contamination Check

Hydrostatic head fluid was used as wash water during the 1995/1996 core sampling event for tank 241-U-109. Lithium bromide was added to the HHF as a tracer, and its presence in the core samples would indicate contamination by the HHF. Because HHF is essentially water, the significance of any contamination is the possibility of a bias in the weight percent water analytical results and in the analytical results for all other analytes. This check, through analyses for lithium and bromide, was prescribed by the SAP (Baldwin 1996b). The analytical results for lithium and bromide were not included in Table 4-2 because they are not constituents of the tank waste. The tabulated results are reported in Appendix B.

Bromide was detected in the solids and drainable liquid samples of core 124, segment 3, and in the solids results from core 128, segment 5. However, lithium was not detected in either of these two segments (or in any others). The absence of lithium has been observed in other sampling events and is believed to be due to the precipitation of non-soluble lithium salts. Using HHF correction calculations for bromide, it was found that over 50 percent[1] of the water present in the solids and drainable liquid portions of core 124, segment 3 were from HHF. Based on this evidence (along with the higher weight percent water measured for this segment), and the fact that this was the only segment to have drainable liquid, these weight percent water results were not considered valid, and were not utilized in the overall mean estimates or any other evaluations. A close examination of the core 124, segment 3 solids data for detected analytes (such as aluminum, sodium, total alpha activity, TOC, and especially density), does not reveal any obvious discrepancies with the analytical results from neighboring segments (see Appendix A tables). Therefore, all solids data (except weight percent water) from this segment were retained. The core 124, segment 3 drainable liquid result is reported in the Appendix A tables for information only. The HHF correction calculations for core 128, segment 5 yielded a weight percent water result of 27.62, compared with the analytical result of 35.02 percent. Since this was less than a 50 percent difference (21 percent), all data from this segment were retained, and the corrected percent water value of 27.62 was utilized in all data evaluations (Baldwin 1996a).

4.2 DATA SUMMARY OF 1995 VAPOR SAMPLING

Vapor samples taken from the headspace of the waste storage tank 241-U-109 were obtained to characterize the vapors present in the tank headspace, and to support safety evaluations and tank farm operations. The results include air concentrations of selected inorganic and organic analytes and grouped compounds from samples obtained by Westinghouse Hanford Company and provided for analysis to the Pacific Northwest National Laboratory (PNNL).

[1]If greater than 50 percent of the water present is from HHF, then the sample must be considered suspect (Winkelman 1996).

Analyses were performed by the vapor analytical laboratory at PNNL. A summary of the inorganic analytes, permanent gases, and total non-methane hydrocarbons is listed in Table 4-4.

Table 4-4. Summary Results of Samples to Characterize the Headspace of Tank 241-U-109 on August 10, 1995.

Category	Sample Medium	Analyte	Vapor[1] Concentration	Units
Inorganic Analytes[2]	Sorbent traps	NH_3	577 ± 20	ppmv
		NO_2	≤ 0.06	ppmv
		NO	≤ 0.06	ppmv
		H_2O	14.8 ± 0.4	mg/L
Permanent Gases	SUMMA™ canister	CO_2	< 25	ppmv
		CO	< 25	ppmv
		CH_4	< 25	ppmv
		H_2	748	ppmv
		N_2O	868	ppmv
Total non-methane hydrocarbons (TO-12)	SUMMA™ canister	Hydrocarbons	9.25	mg/m^3
Volatile organics (TO-14)	SUMMA™ canister	Methyl alcohol	0.408	ppmv
		Trichlorofluoromethane	0.350	ppmv
		Acetone	0.223	ppmv
Semi-volatile organics (PNL-TVP-10)	Sorbent traps	Ethane, 1-chloro-1, 1-difluoro-	0.733	ppmv
		Ethanol	0.432	ppmv
		Trichlorofluoromethane	0.330	ppmv

Notes:

[1]Vapor concentrations were determined using sample-volume data provided by Westinghouse Hanford Company and are based on averaged data.

[2]Inorganic analyte concentrations are based on dry tank air at standard temperature and pressure.

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5.0 INTERPRETATION OF CHARACTERIZATION RESULTS

The purpose of this chapter is to discuss the overall quality and consistency of the current sampling results for tank 241-U-109, and to assess and compare these results against historical information and program requirements.

5.1 ASSESSMENT OF SAMPLING AND ANALYTICAL RESULTS

This section evaluates sampling and analysis factors that may impact interpretation of the data. These factors are used to assess the overall quality and consistency of the data and to identify any limitations in the use of the data.

5.1.1 Field Observations

The safety screening (Dukelow et al. 1995), organic complexant safety (Turner et al. 1995), and historical model evaluation (Simpson and McCain 1995) DQOs all required vertical profiles of the waste from at least two widely-spaced risers. This requirement was fulfilled, allowing a spatial examination of the analyte concentrations. Contamination of the core 124, segment 3 sample by HHF resulted in all drainable liquid data and the solids weight percent water data from this segment being excluded from the mean calculations and other evaluations. HHF intrusion of core 128, segment 5 resulted in the adjustment of the weight percent water value. No further anomalies that might limit the use of the data were noted.

5.1.2 Quality Control Assessment

The usual QC assessment includes an evaluation of the appropriate standard recoveries, matrix spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. All the pertinent QC tests were conducted on the 1995/1996 core samples, allowing a full assessment regarding the accuracy and precision of the data. As indicated in the SAP, the specific criteria for all QC checks were governed by the *Hanford Analytical Services Quality Assurance Plan* (DOE 1995). QC results outside these criteria are identified by superscripts in the Appendix A and Appendix B tables for all analytes. A summary of the QC results is presented below.

The standard and spike recovery results provide an estimate of the accuracy of the analysis. If a standard or spike recovery is above or below the given criterion, then the analytical results may be biased. All standard recoveries were within the defined criteria with the exception of one of nine total beta results, which was slightly above the limit. Total alpha activity had 6 of 39 matrix spikes below the criterion of 75 to 125 percent recovery. This was probably due to large sample sizes, which resulted in high amounts of solid material on the sample mount and possible self-shielding (Baldwin 1996a). TOC had just one of 18 results outside of the limit. For sodium, half of the spike recoveries for the fusion-digestion results were below the criterion, and the three conducted on the acid-digested results were well above the criterion. These poor recoveries were probably due to the high dilutions required to measure the large sodium concentrations. The few spike recovery deviations for the remainder of the analytes were very minor.

Analytical precision is estimated by the relative percent difference (RPD), which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times 100. Total alpha activity had 16 of 39 RPDs above the criterion, probably due to low sample activities and possible self-shielding. Reruns were not requested because the largest sample mean was 250 times below the decision criteria threshold and the results were near the detection limit. Regardless, the spike recovery and RPD deviations for total alpha activity were not substantial enough to affect the criticality evaluation. Six of the 13 samples with exothermic reactions had RPDs above the criterion. This was not unusual given the small sample sizes and possible sample heterogeneity problems. Several other analytes displayed minor RPD deviations, likely due to sample concentrations near the detection limit that adversely impacted the reproducibility of the results. Finally, none of the samples exceeded the criteria for preparation blanks; thus, contamination was not a problem for any of the analytes.

In summary, practically all of the QC results were within the boundaries specified in DOE (1995). The few discrepancies noted should not impact either the validity or the use of the data.

5.1.3 Data Consistency Checks

The comparison of results from different analytical methods can help to assess the consistency and quality of the data. Close agreement between the two methods strengthens the credibility of both results, whereas poor agreement brings the reliability of the data into question. Sufficient anion data was not requested in the SAP for calculation of mass and charge balances. A comparison of the total beta activity with the activities of the individual beta emitters was made using the analytical mean composite level results for the total beta measurement, and the activities of $^{89/90}Sr$ and ^{137}Cs given in the Appendix A tables. The sum of the beta emitters was calculated as follows:

$$\text{Sum of beta emitters} = (2 * {}^{89/90}\text{Sr} + {}^{137}\text{Cs})$$

Because $^{89/90}Sr$ is in equilibrium with its daughter product ^{90}Y, the $^{89/90}Sr$ activity must be multiplied by 2 to account for all of the beta emitters. This comparison is shown in Table 5-1. The activities of the two methods compared well, yielding a ratio of 1.08.

Table 5-1. Comparison of Total Beta Activity with the Sum of $^{89/90}Sr$ and ^{137}Cs Activities.

Analyte	Overall Mean (μCi/g)	Beta Activities (μCi/g)
$^{89/90}Sr$	9.70	19.4
^{137}Cs	122	122
Sum of beta emitters		141
Total beta activity		131
Ratio		1.08

5.2 COMPARISON OF HISTORICAL WITH ANALYTICAL RESULTS

Before the 1995/1996 core sampling event, the most recent sampling of tank 241-U-109 took place in November 1975. Due to multiple transfers in the following years, no valid comparison between any the 1995/1996 and 1975 results is possible. The 1975 results are reported in Appendix C for information only.

5.3 TANK WASTE PROFILE

According to the estimate of Hanlon (1996), the 449 cm (176.7 in.) of waste in tank 241-U-109 consists of 72 kL (19 kgal) of supernatant covering 1,499 kL (396 kgal) of saltcake and 182 kL (48 kgal) of sludge. The saltcake and sludge layers include 617 kL (163 kgal) of drainable interstitial liquid. The TLM estimates were similar to those of Hanlon (1996), but divided the saltcake layer into roughly equal portions of saltslurry and saltcake, as well as dividing the bottom sludge layer into equal portions of CRW1 and MW (see Figure 2-3).

The photographic montage of the waste surface showed a mixture of solids and liquids, and possibly orange-colored saltcake floating on the liquid.

The visual descriptions of the samples indicated some variations in color between segments, with medium gray being predominate, but also with some blue, brown, white, yellow, or black. The texture varied from wet and slushy saltcake to dry and granular saltcake. The descriptions comparing the segments where the two saltcake layers would be expected were quite similar. The bottom segment from the three cores coincides with the two thin sludge layers predicted by the TLM (Agnew 1996a), and their visual descriptions did differ from the other segments, but were not consistent with each other. Based on all of the above information, the tank waste appears to be somewhat heterogeneous.

Standard statistical ANOVA (analysis of variance) models were fit to the 1995/1996 core, segment, and subsegment data. The results from these models can be used to judge the vertical and horizontal variability in analyte concentrations. Nested random-effects ANOVA models were fit to the analytical data, provided that at least 50 percent of the individual primary and duplicate measurements were above detection limits.

The p-value, from the ANOVA models, is compared to a standard significance level ($\alpha = 0.05$). If it is less than 0.05, then the analyte means are significantly different from each other. However, if a p-value is greater than 0.05, the analyte means are not significantly different from each other. In the following paragraphs, the p-values are in parentheses.

Nine analytes had subsegment data from multiple core samples. The results of the ANOVA indicated that there were significant differences in the mean concentration between subsegments for all nine analytes (all p-values <0.0001).

Fifteen analytes had segment data from multiple core samples. The results from five of the analytes were based on an acid digestion and the results from the other 10 analytes were based on a fusion digestion of subsamples. Based on the acid digestion results, there were significant differences in the mean concentrations between segments for 4 of the 5 analytes [aluminum (< 0.001), chromium (< 0.001), total beta (< 0.001), and $^{89/90}Sr$ (< 0.001)]. For the fusion-digestion results, there were significant differences in mean concentrations between the segments for 4 of the 10 analytes [nitrate (< 0.001), TIC (0.012), total alpha activity (0.006), and ^{137}Cs (0.004)].

In addition, for the segment level data, there were no significant differences in the mean analyte concentration between the three core samples based on the acid-digestion results. For the fusion-digestion results, there were significant differences in mean concentration between the three core samples for chromium (0.007) and weight percent water (0.032).

An ANOVA model was also fit to concentration data on 16 analytes based on core composite samples. There were significant differences between the mean analyte concentrations, based on core composite samples, for 10 analytes [aluminum, acid-digestion (0.004); aluminum, fusion-digestion (0.025); chromium, fusion-digestion (0.003); sodium, fusion-digestion (0.001); nitrate (0.003); TOC (0.040); weight percent water (0.016); total beta (0.001); ^{137}Cs (< 0.001); and $^{89/90}Sr$ (0.002)].

In summary, the Hanlon (1996) estimates, the TLM, the photo montage, the visual descriptions of the samples, and the statistical results all indicated a certain degree of vertical heterogeneity. The evidence for horizontal heterogeneity is less pronounced than that for vertical heterogeneity. Data from 31 analytes were evaluated. There were significant differences in mean concentrations between core samples for only 12 of the analytes (39 percent). In addition, the differences in the visual descriptions of the samples were less pronounced between cores than they were between segments.

5.4 COMPARISON OF TRANSFER HISTORY WITH ANALYTICAL RESULTS

The HTCE (Agnew 1996a) estimates of the tank contents are compared with the analytical results from the 1995/1996 sampling event in Table 5-2. The HTCE values are generated using a combination of several data sources, as described in Section 2.3.2. Each of these data sources contains assumptions and/or other factors (such as transfers of an unknown waste type into the tank) that may impact the modeled concentrations presented in the HTCE. Since the HTCE values have not been validated, these comparisons are presented for information only. The results compared quite favorably given the uncertainties inherent in the HTCE values.

Table 5-2. Comparison of HTCE with 1995/1996 Analytical Results for Tank 241-U-109.

Analyte	Model Estimate	1995/1996 Segment Level Analytical Result	1995/1996 Fusion Composite Analytical Result
METALS	**µg/g**	**µg/g**	**µg/g**
Aluminum	38,200	19,700	19,700
Chromium	2,090	3,690	3,590
Sodium	1.91E+05	2.21E+05	2.27E+05
ANIONS	**µg/g**	**µg/g**	**µg/g**
Nitrate	2.13E+05	3.08E+05	3.31E+05
RADIONUCLIDES	**µCi/g**	**µCi/g**	**µCi/g**
^{137}Cs	167	112	122
$^{89/90}Sr$	87.7	6.89[1]	9.70
CARBON	**µg C/g**	**µg C/g**	**µg C/g**
Total inorganic carbon	4,480	7,550	8,340
Total organic carbon	10,200	3,600	3,780
PHYSICAL PROPERTIES			
Weight percent water	27.3 %	23.7 %	25.3 %
Density	1.71 g/mL	1.67 g/mL	1.75 g/mL

Note:
[1]Results from two segments only, from each of the three cores. See Appendix A, Table A-20.

5.5 EVALUATION OF PROGRAM REQUIREMENTS

The 1995/1996 core sampling event was governed by three DQOs and a test plan. The safety screening DQO (Dukelow et al. 1995) lists requirements for examining the waste in each Hanford underground waste tank to identify safety problems, and to evaluate the tank for placement on a Watch List or to verify current Watch List status. Tank 241-U-109 is currently on the Flammable Gas Watch List. The organic complexant safety DQO (Turner et al. 1995) addresses the possibility of an exothermic reaction between organic complexants and precipitated nitrate or nitrite salts. The organic safety test plan (Meacham 1995) examines the flammability potential of tanks containing entrained organic solvents. Finally, the historical model evaluation DQO (Simpson and McCain 1995) attempts to acquire information through selective tank sampling to quantify the errors associated with the predictions for the waste composition. These issues were integrated by the SAP (Baldwin 1996b) into a list of required analytical tests and their respective decision criteria thresholds.

Section 5.5 discusses the requirements of each DQO and the test plan, and compares the analytical data to their decision criteria thresholds. Section 5.5.1 discusses each safety issue as identified in the safety screening and organic complexant safety DQOs and the organic safety test plan, as well as evaluating the estimated tank heat load. Section 5.5.2 examines the historical model evaluation.

5.5.1 Safety Evaluation

The safety screening DQO requirement that vertical profiles of the waste be obtained from at least two widely-spaced risers was met. Of the five primary analyses required by this DQO, three have decision criteria thresholds which, if exceeded, could warrant further investigation to ensure tank safety. These three analyses include DSC to evaluate the fuel content, total alpha activity to determine the criticality potential, and a determination of the flammability of the gases in the tank headspace.

Regarding the organic complexant safety DQO, the optimum number of waste profiles required is based on information such as historical sampling or prior sampling activities. If specific information is not available, two vertical profiles will be obtained from widely-spaced risers. Tank 241-U-109 was evaluated in accordance with this DQO because the tank was identified as possibly containing $>$ 3 weight percent TOC by a review of waste transfer records (Turner et al. 1995). The primary analyses required by this DQO are DSC, TGA to determine the moisture content, and a TOC analysis to estimate its contribution to the total fuel content. Decision criteria thresholds were also established by the DQO for these analytes.

The organic safety test plan supplements the two DQOs mentioned above, although the decision criteria thresholds are less stringent. It attempts to confirm tank fuel content models through resolution of three safety issues: organic solvent fires, organic complexant condensed phase propagating reactions, and ferrocyanide propagating reactions. Required analyses include DSC, TGA, and TOC.

Table 5-3 lists the applicable primary decision variables, DQOs or test plan, decision criteria thresholds, and the analytical results from the 1995/1996 core sampling event for the safety screening and organic complexant safety DQOs and the organic safety test plan.

Table 5-3. Decision Variables and Criteria for the Safety Screening and Organic Complexant Safety Data Quality Objectives and the Organic Safety Test Plan. (2 sheets)

Primary Decision Variable	Applicable DQO or Test Plan	Decision Criteria Threshold	Analytical Results
Total fuel content[1]	Safety screening	480 J/g	All exothermic reactions ≤ 301.9 J/g. Highest upper limit to a one-sided 95% confidence interval on the mean = 493.4 J/g.[2]
	Organic complexant	480 J/g	
	Organic test plan	1,200 J/g	
Total organic carbon[1,3]	Organic complexant	30,000 μg C/g	Mean = 4,720 μg C/g Highest upper limit to a one-sided 95% confidence interval on the mean = 18,600 μg C/g.[4]
	Organic test plan	45,000 μg C/g	
Weight percent water	Organic complexant	17 wt %	Mean = 23.7 wt % low = 6.38 wt %[5]
	Organic test plan	0.022 [Fuel (in J/g) -1,200] wt %, or 20 wt %	
Total alpha activity	Safety screening	41 μCi/g[6]	mean = 0.0371 μCi/g Highest upper limit to a one-sided 95% confidence interval on the mean = 0.156 μCi/g[7].
Separable organic layer	Safety screening	Detected/not detected	None observed
Flammable gas	Safety screening	25 % of the LFL	5 % of the LFL

Table 5-3. Decision Variables and Criteria for the Safety Screening and Organic Complexant Safety Data Quality Objectives and the Organic Safety Test Plan. (2 sheets)

Notes:

[1]All decision criteria thresholds and analytical results are given as dry weight values.

[2]This is the only 95 percent confidence interval upper limit that exceeded the decision threshold of 480 J/g. It was located in the lower half of core 128, segment 4. This value was most likely above the limit because of variability in the data (Baldwin 1996a).

[3]All decision criteria thresholds for TOC were based on the fuel value of sodium acetate.

[4]This 95 percent confidence interval upper limit was obtained from subsegment A of core 123, segment 9.

[5]This weight percent water result was the lowest sample mean measured, and was obtained from the upper half of core 123, segment 3.

[6]Although the actual decision criteria threshold listed in the DQO was 1 g/L, total alpha activity was reported in μCi/g rather than g/L. To convert the notification limit for total alpha into the same units as those used by the laboratory, it was assumed that all alpha decay originated from ^{239}Pu. The SAP assumed a tank density of 1.5 g/mL, and using the specific activity of ^{239}Pu (0.0615 Ci/g), the decision criteria threshold was converted to 41 μCi/g using the equation below (Baldwin 1996b). This equation was also used to establish specific decision thresholds for each sample mean with a density greater than 1.5 g/mL, as directed by the SAP. The sample with the highest density, 1.97 g/mL, was quarter segment C from core 123, segment 9. This density was converted to a decision threshold of 31.2 μCi/g, representing the lowest threshold for any of the sludge samples. The conversion is presented below.

$$\left[\frac{1\ g}{L}\right]\left[\frac{1\ L}{10^3\ mL}\right]\left[\frac{1}{density}\ \frac{mL}{g}\right]\left[\frac{0.0615\ Ci}{1\ g}\right]\left[\frac{10^6\ \mu Ci}{1\ Ci}\right] = \frac{61.5}{density}\ \frac{\mu Ci}{g}.$$

[7]This 95 percent confidence interval upper limit was obtained from core 128, segment 1.

The following DSC results are all given on a dry weight basis. Both the safety screening and organic complexant safety DQOs have established a decision criteria threshold of 480 J/g for the DSC analyses, while the organic safety test plan established a decision threshold of 1,200 J/g. Exothermic reactions were noted in several of the samples, but they were all below the DQO thresholds (see Table 4-3). The single highest exothermic reaction showed a change in enthalpy of 301.9 J/g. One of the upper limits to a one-sided 95% confidence limit on the mean was greater than the decision threshold (493.4 J/g), but this was attributed to variability in the data (Baldwin 1996a).

The following TOC results are all given on a dry weight basis. The organic complexant safety DQO established the decision criteria threshold for TOC at 30,000 μg C/g, whereas the decision threshold for the organic safety test plan was 45,000 μg C/g. The mean TOC concentration was 4,720 μg C/g, the largest sample mean result was 15,400 μg C/g, and the highest upper limit to a one-sided 95 percent confidence interval on the mean for a single primary-duplicate pair was 18,600 μg C/g. All analytical results were thus far below the decision thresholds.

To investigate the relationship between DSC and the TOC content, the DSC dry weight results for those subsegments that had exothermic reactions are compared with the corresponding dry weight TOC results and the TOC energy equivalents in Table 5-4. This comparison may be biased since DSC reports net enthalpy change; if endotherms are present, they could mask the full extent of the actual exothermic reactions. The TOC data were converted to their energy equivalent using the following equation (Baldwin 1996b). The 632 J/g value represents the energy equivalent of 5 weight percent TOC, based on a sodium acetate average energetics standard. Assuming that all of the TOC is present as sodium acetate may also bias this comparison.

$$Energy\ Equivalent = wt\%\ TOC\ (dry\ weight)\ \frac{(632\ J/g)}{5}$$

Several of the sample means for weight percent water were below the organic complexant safety DQO decision threshold of 17 weight percent, the lowest sample mean being 6.38 weight percent. However, secondary analyses are only required if both the fuel and moisture decision limits are violated for a given subsegment. Because none of the DSC results showed exothermic reactions with a change in enthalpy greater than the decision threshold of 480 J/g, the low weight percent water values were not a concern. The weight percent water decision threshold for the organic safety test plan was 0.022 [Fuel (in J/g) - 1,200] weight percent, or 20 weight percent. Since all fuel values were far below the decision threshold of 1,200 J/g (the minimum amount of fuel that the test plan considers necessary to support a propagating reaction), the moisture content of the tank was not a factor.

The potential for criticality can be assessed from the total alpha activity data. The safety screening DQO decision criteria threshold is 1 g/L. Since the laboratory reported total alpha activity in units of μCi/g, the 1 g/L threshold was converted to 41 μCi/g, assuming a density of 1.5 g/mL (Baldwin 1996b). If the analytical density for a particular sample mean exceeds 1.5 g/mL, then the threshold is adjusted according to the equation given in Table 5-3, Footnote 6. Several of the sample densities were greater than 1.5 g/mL, the largest being 1.97 g/mL. This resulted in the lowest decision threshold being 31.2 μCi/g for quarter segment C from core 123, segment 9. The overall tank mean was 0.0371 μCi/g, the highest sample mean was 0.150 μCi/g, and the highest upper limit to a one-sided 95 percent confidence interval on the mean was 0.156 μCi/g. Thus, all analytical and confidence interval results were well below their respective safety screening DQO decision criteria thresholds.

Table 5-4. Comparison of DSC Analytical Results With TOC Energy Equivalents (Dry Weight Basis).

Core: Segment	Sub-Segment	Run	TOC Analytical Result	TOC Energy Equivalent	DSC Analytical Result[1]
			µg C/g	J/g	J/g
123:6	Lower ½	1	6,000	75.8	101
		2	6,190	78.2	130.1
		3	---[2]	---[2]	77.8
123:9	A, top ¼	1	15,900	201	30.5
		2	14,800	187	57.3
124:5	Lower ½	1	5,850	73.9	273.6
		2	5,790	73.2	301.9
124:6	Upper ½	1	8,290	105	252.7
		2	7,630	96.4	270
124:6	Lower ½	1	9,480	120	141.1
		2	9,790	124	151.7
128:1	Whole	1	7,220	91.3	0
		2	6,960	88.0	21.2
		3	---[2]	---[2]	30.8
128:4	Lower ½	1	12,800	162	267.6
		2	11,100	140	182.6
128:5	Whole	1	5,900	74.6	13.70
		2	6,160	77.9	21.24
128:6	Lower ½	1	8,070	102	111.4
		2	7,710	97.5	116.1
128:7	Lower ½	1	9,660	122	131.1
		2	9,740	123	134.4
128:8	Lower ½	1	6,990	88.4	0
		2	7,420	93.8	112.2
		3	---[2]	---[2]	70.3

Notes:

[1]The negative sign indicating an enthalpy change involving an exothermic reaction was not included because total energy in J/g is being compared between the DSC and TOC results.

[2]Triplicate runs were not conducted on any of the TOC samples.

The flammability of the gas in the tank headspace is an additional safety screening DQO consideration. The requirement is that any flammable gas present must be below 25 percent of the LFL. The analytical results showed a maximum of 5 percent of the LFL.

Another factor in assessing tank safety is the heat generation from radioactive decay and the resultant temperature increase of the waste. The 1995/1996 analytical results provided mean estimates for ^{137}Cs and $^{89/90}Sr$. Table 5-5 predicts the tank heat load to be 1,880 W (6,420 Btu/hr). The HTCE provided an estimate of 4,120 W (14,100 Btu/hr), and Kummerer (1994) estimated 1,720 W (5,865 Btu/hr) based on tank headspace temperatures. All of these estimates were well below the 11,700 W (40,000 Btu/hr) design specification for single-shell tanks (Bergmann 1991). Since an upper temperature limit has been exhibited (Section 2.4.3), it may be concluded that any heat generated from radioactive sources throughout the year is dissipated.

Table 5-5. Tank 241-U-109 Estimated Heat Load.[1]

Radionuclide	μCi/g	Ci	Watts
^{137}Cs	122	3.57E+05	1,690
$^{89/90}Sr$	9.70	28,400	190
Total		3.85E+05	1,880

Note:
[1]Because the composite level mean was higher than the segment level mean for both analytes, the composite analytical results were used in order to provide the most conservative estimate.

5.5.2 Historical Model Evaluation

The primary objective of the historical model evaluation DQO is to acquire adequate information through selective tank sampling to quantify the errors associated with predicting tank waste composition based on waste transaction history and waste type compositions (Simpson and McCain 1995).

The DQO identifies key waste components or key analytes for certain waste types, including SMMS2 saltslurry and SMMS1 saltcake. Tank 241-U-109 was selected for historical evaluation because it was expected to contain layers thick enough to provide entire segments composed of these two waste types (Agnew et al. 1996a). The first step in the evaluation is to compare the analytical results with DQO-defined concentration levels for the key analytes. This comparison indicates that the predicted waste type is in the tank and at the predicted location within the waste. If the analytical results are ≥ 10 percent of the DQO levels (ratio of 0.1 or more), the waste type and layer identification are considered acceptable, and further analyses are requested (Simpson and McCain 1995).

According to the TLM (Figure 2-3), segments 1 through 4 should be SMMS2 saltslurry and segments 5 through 8 should consist of SMMS1 saltcake. Segment 9 was predicted to be CWR1 and MW. The analytical results for the key analytes were compared to the historical model evaluation DQO-predicted concentrations for the SMMS2 saltslurry and SMMS1 saltcake waste types. The key analytes for these two waste types were sodium, aluminum, chromium (SMMS2 saltslurry only), carbonate, nitrate, and weight percent water. The comparisons were made on the segment level for all three cores, and the results indicate that all of the analytical results for the key analytes exceeded the 10 percent criterion specified in the DQO, with the exception of the carbonate data from core 123, segments 2, 3 (upper 1/2), and 3 (lower 1/2). In general, however, it appears that the predicted waste types are present in the tank.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The waste in tank 241-U-109 was core-sampled in December 1995 and January 1996, and analyzed in accordance with the safety screening, organic complexant safety, and historical model evaluation DQOs and the organic safety test plan. The safety issues evaluated included energetics to determine the fuel content, TOC to determine its contribution to the total fuel content, weight percent water, total alpha activity to assess criticality, and flammable gas concentration. The SAP (Baldwin 1996b) required the laboratory to perform ICP and IC analyses for lithium and bromide to determine whether any samples were contaminated by HHF. Also, the historical model evaluation DQO required analyses of several additional analytes that will be used in an attempt to quantify the errors involved in predicting tank waste composition. All samples were analyzed at the Westinghouse Hanford Company 222-S Analytical Chemistry Laboratory. Vapor samples were taken from the headspace of the tank on August 10, 1995 and analyzed to characterize the vapors present in the tank headspace according to the vapor sampling DQO.

Regarding the safety evaluation, comparisons were made between the analytical results and the decision criteria thresholds listed in the safety screening and organic complexant safety DQOs and the organic safety test plan. All of the following DSC and TOC values are given on a dry weight basis. No exothermic reactions with a change in enthalpy above 301.9 J/g were observed in any of the samples, as compared with the safety screening and organic complexant safety DQOs decision criteria threshold of 480 J/g, and the organic safety test plan decision threshold of 1,200 J/g. Although the upper limit of the one-sided 95 percent confidence interval on the mean was 493.4 J/g, this was attributed to variability in the data (Baldwin 1996a).

The overall mean TOC result was 4,720 μg C/g, the highest sample mean was 15,400 μg C/g, and the highest one-sided 95 percent confidence interval upper limit on the mean was 18,600 μg C/g. All results were below the decision thresholds of 30,000 μg C/g from the organic complexant safety DQO and 45,000 μg C/g from the organic safety test plan. The weight percent water results were not critical from a safety viewpoint because neither the organic complexant DQO nor the organic safety test plan required a minimum percentage of water in the absence of exothermic reactions above the decision thresholds. No separable organic layer was detected in any of the samples. The highest sample mean for total alpha activity was 0.150 μCi/g, the highest one-sided 95 percent confidence interval upper limit on the mean was 0.156 μCi/g, and the overall mean was 0.0371 μCi/g. All total alpha activity values were at least two orders of magnitude below their safety screening thresholds. Vapor analysis showed all samples to be well below limits and do not indicate a safety concern.

The flammability of the gas in the tank headspace is an additional safety screening DQO consideration. The decision threshold is that any flammable gas present must be below 25 percent of the LFL. This measurement was especially important considering that tank 241-U-109 is on the Flammable Gas Watch List. The analytical results showed a maximum of 5 percent of the LFL.

Based on analytical results, the estimated tank heat load was 1,880 W (6,420 Btu/hr). The HTCE estimate of the tank heat load was 4,120 W (14,100 Btu/hr), while the estimate based on the headspace temperature was 1,720 W (5,865 Btu/hr). All three estimates were below the 11,700 W (40,000 Btu/hr) high-heat threshold (Bergmann 1991). Since the tank exhibits an upper temperature limit, it is concluded that any heat generated from radioactive sources throughout the year is dissipated.

According to the criteria established in the safety screening and organic complexant DQOs and the organic safety test plan, the tank is considered safe.

The historical model evaluation DQO attempts to verify the presence of particular waste types by comparing the predicted concentrations of certain analytes with the analytical results. The results of these comparisons indicated that the tank does contain the predicted waste types.

Hydrostatic head fluid marked with a lithium bromide tracer was used during core sampling operations, and contamination of over 50 percent occurred in segment 3 of core 124. Thus, the drainable liquid results and the solids weight percent water results from this segment were not used in any evaluations concerning this tank. Some HHF intrusion was also noted in segment 5 of core 128. Because this contamination was less than 50 percent, the weight percent water results were corrected for the intrusion and used in all data evaluations.

A number of observations can be made concerning this tank:

1. Although tank 241-U-109 is on the Flammable Gas Watch List, the flammable gas concentration in the headspace is well below the threshold and is not a cause for concern.

2. The metal waste heel has a level of uranium that exceeds the value predicted from the transfer history.

3. The aluminum in the waste is mostly soluble in water. This agrees with the process history.

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APPENDIX A

ANALYTICAL RESULTS FROM 1995/1996 CORE SAMPLING OF SINGLE-SHELL TANK 241-U-109

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A.0 ANALYTICAL RESULTS FROM 1995/1996 CORE SAMPLING OF SINGLE-SHELL TANK 241-U-109

A.1 INTRODUCTION

Appendix A reports the chemical, radiochemical, and physical characteristics of tank 241-U-109 in table form and in terms of the specific concentrations of metals, ions, radionuclides, and physical properties.

Each data table lists the following: laboratory sample identification, sample origin (core/segment/subsegment, or composite), an original and duplicate result for each sample, a sample mean, a mean for the tank in which all three core means are weighted equally, an RSD (mean), and a projected tank inventory for the particular analyte using the weighted mean, the waste volume, the density, and the appropriate conversion factors. The projected tank inventory column is not applicable to the weight percent water, DSC, or density data. The data are listed in standard notation for values greater than 0.001 and less than 100,000. Values outside these limits are listed in scientific notation.

The tables are numbered A-1 through A-27. A description of the units and symbols used in the analyte tables and the references used in compiling the analytical data (Baldwin 1996a) are found in the List of Terms and Section 7.0, respectively. For a description of the sampling event and information on sampling rationale and locations, see Section 3.0.

A.2 ANALYTE TABLE DESCRIPTION

The "Sample Number" column lists the laboratory sample for which the analyte was measured.

Column two specifies the core and segment from which each sample was derived.

Column three specifies the subsegment or whole segment for which the analyte was measured. If adequate sample was available, the waste from a given segment was split into upper and lower halves, or divided into subsegments (A, B, and C). If inadequate material was recovered to split the segment, it was analyzed as a "whole" segment. The single drainable liquid result is identified as "DL".

The "Result" and "Duplicate" columns are self-explanatory. The "Sample Mean" column is the average of the result and duplicate values. If the result and duplicate values were both nondetected or detected, then the mean is expressed as a nondetected or detected value, respectively. If one of the two values is nondetected and one is detected, the sample mean is expressed as a detected result. The result and duplicate values, as well as the result/duplicate means, are reported in the tables exactly as found in the original laboratory data package. The means may appear to have been rounded up in some cases and rounded down in others. This is because the analytical results given in the tables may have fewer significant figures than originally reported, not because the means were incorrectly calculated.

The overall (or analyte concentration) means for the waste in tank 241-U-109 are given in column seven, and were calculated as follows.

To obtain the overall weighted mean for the solids portion of the tank contents based on the segment level results, the individual sample result and duplicate pairs within a given subsegment were first averaged to obtain a sample mean. The DSC, TGA, TIC and TOC analyses each had several triplicate runs conducted, and they were averaged into the calculation of the particular subsegment means. The subsegment means within a given segment were then averaged to obtain a segment mean, the segment means within a given core were averaged to obtain a core mean, and finally the three core means were averaged to obtain the overall mean. Not all of these steps were necessary for each analyte or for each subsegment, but the procedure to be followed is the same.

All values, including those below the detection level (indicated by the less-than symbol, <), were used in calculating the overall means. If 50 percent or more of all the individual sample and duplicate results were detected, then the overall mean was expressed as a detected value. If greater than 50 percent of all the individual results were nondetected, then the overall mean was expressed as a nondetected value. The implication associated with nondetected numbers as quantitative observations results in the mean concentrations and inventory estimates being biased. The magnitude of the bias is unknown and the results should be used with caution.

Separate overall means were also calculated for the segment level acid-digestion analyses and the various composite samples following the same detected/nondetected rules specified above. The overall means for segment level acid-digested analytes were weighted in the same manner as the segment level analyses specified above. The overall means for the acid and fusion-digestion composite samples were a simple average of the three core means. As discussed in Section 4-4, drainable liquid means, RSDs, and inventories were not calculated due to HHF contamination, but the analytical results are included in the following tables for information.

The RSD (mean), given in column eight, was computed for applicable analytes using standard ANOVA statistical techniques (nested models). If the overall mean for a given analyte was "detected", then an RSD (mean) was also calculated for that analyte. Because all "detected" means also had all of the individual sample/duplicate results detected, there are no unknown biases in the statistical calculations for tank 241-U-109.

As discussed in Section 4.1.4, HHF contamination precluded the use of the weight percent water data from core 124, segment 3. The results are reported in Table A-25 for information only, and were not used in the overall mean estimates or any other evaluations. The solids data for this subsegment were retained, as a close examination of the data did not reveal any obvious discrepancies with the analytical results from neighboring segments. A low level of HHF contamination occurred in segment 5 of Core 128. The weight percent water results were corrected for the contamination, and the corrected values were used in the overall mean estimate and other evaluations. See Section 4.1.4 for a more complete discussion.

The projected inventory, given in column nine, is the product of the overall analyte concentration mean, the volume of tank waste (1,753 kL [463 kgal]), the density (1.67 g/mL), and the appropriate conversion factors. Because the only DL recovered was most likely HHF, it was decided to use the entire tank inventory estimate of 1,753 kL (463 kgal) in calculating the solids inventory.

The four quality control parameters assessed on the tank 241-U-109 samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. These were summarized in Section 5.1.2. More specific information is provided in the following tables. Sample and duplicate pairs in which any of the QC parameters were outside their specified limits are superscripted in column 6 as follows:

QC:a -- indicates that the standard recovery was below the QC range.
QC:b -- indicates that the standard recovery was above the QC range.
QC:c -- indicates that the spike recovery was below the QC range.
QC:d -- indicates that the spike recovery was above the QC range.
QC:e -- indicates that the RPD was greater than the QC limit range.
QC:f -- indicates blank contamination.

Table A-1. Tank 241-U-109 Analytical Results: Aluminum. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000256	123:1	Whole	7,920	8,240	8,080	19,700	32.6	57,700
S96T000259	123:2	Whole	19,500	18,800	19,200			
S96T000260	123:3	Upper ½	4,470	4,360	4,420			
S96T000261		Lower ½	4,980	4,310	4,640			
S96T000262	123:4	Whole	7,840	5,030	6,440[QC:e]			
S96T000263	123:5	Whole	10,100	9,060	9,580			
S96T000264	123:6	Upper ½	15,200	15,800	15,500			
S96T000265		Lower ½	14,600	13,500	14,000			
S96T000266	123:7	Upper ½	15,900	11,000	13,400[QC:e]			
S96T000267		Lower ½	11,700	9,360	10,500[QC:e]			
S96T000268	123:8	Upper ½	10,800	11,400	11,100			
S96T000269		Lower ½	11,900	11,400	11,600			
S96T000270	123:9	A	11,300	10,900	11,100			
S96T000271		B	1.85E+05	1.90E+05	1.88E+05[QC:d]			
S96T000272		C	2.11E+05	2.16E+05	2.14E+05[QC:d]			
S96T000344	124:2	Whole	7,130	7,820	7,480			
S96T000345	124:3	Whole	10,200	11,800	11,000			
S96T000346	124:4	Whole	8,490	8,880	8,680			
S96T000347	124:5	Upper ½	12,600	14,600	13,600			
S96T000348		Lower ½	17,100	16,900	17,000			

Table A-1. Tank 241-U-109 Analytical Results: Aluminum. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000349	124:6	Upper ½	20,000	19,700	19,800	Cont.	Cont.	Cont.
S96T000350		Lower ½	20,000	21,300	20,600			
S96T000351	124:7	Upper ½	10,500	11,700	11,100			
S96T000352		Lower ½	9,120	9,900	9,510			
S96T000353	124:8	Upper ½	13,600	14,300	14,000			
S96T000354		Lower ½	15,100	14,900	15,000			
S96T000355	124:9	Upper ½	12,100	11,200	11,600			
S96T000356		Lower ½	25,500	13,700	19,600[QC:e]			
S96T000498	128:1	Whole	15,500	13,800	14,600			
S96T000499	128:2	Whole	9,800	9,630	9,720			
S96T000500	128:3	Whole	9,930	9,940	9,940			
S96T000501	128:4	Upper ½	10,800	9,890	10,300			
S96T000502		Lower ½	18,200	18,800	18,500			
S96T000503	128:5	Whole	13,400	14,400	13,900			
S96T000504	128:6	Upper ½	15,700	17,700	16,700			
S96T000505		Lower ½	14,900	15,000	15,000			
S96T000506	128:7	Upper ½	14,800	14,400	14,600			
S96T000507		Lower ½	16,700	17,700	17,200			
S96T000508	128:8	Upper ½	10,000	9,590	9,800			
S96T000509		Lower ½	12,900	12,800	12,800			
S96T000510	128:9	Whole	87,000	84,600	85,800			

Table A-1. Tank 241-U-109 Analytical Results: Aluminum. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: water digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T002846	123:4	Whole	1,530	1,670	1,600[QC:d]	8,970	20.5	26,300
S96T002547	123:6	Lower ½	8,460	11,000	9,730[QC:e]			
S96T002847	124:3	Whole	13,600	13,100	13,400[QC:e]			
S96T002848	124:8	Upper ½	11,000	10,400	10,700			
S96T002546	128:2	Whole	7,980	7,540	7,760			
S96T002849	128:7	Upper ½	10,600	10,700	10,600			
Composites: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T001411	123	n/a	24,600	29,200	26,900	19,700	18.9	57,700
S96T001658	124	n/a	16,000	12,800	14,400[QC:e]			
S96T001699	128	n/a	17,800	18,000	17,900			
Composites: water digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T002515	123	n/a	7,750	8,260	8,000[QC:e]	10,000	10.0	29,300
S96T002516	124	n/a	10,700	10,800	10,800			
S96T002517	128	n/a	10,900	11,500	11,200			
Liquids: direct			µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000280	124:3	DL	5,700	5,670	5,680[QC:e]	N/A	N/A	N/A

Table A-2. Tank 241-U-109 Analytical Results: Bismuth. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000256	123:1	Whole	< 2,540	< 2,130	< 2,340	< 2,110	n/a	6,180
S96T000259	123:2	Whole	< 2,510	< 2,380	< 2,450			
S96T000260	123:3	Upper ½	< 1,900	< 1,980	< 1,940			
S96T000261		Lower ½	< 2,010	< 2,070	< 2,040			
S96T000262	123:4	Whole	< 2,140	< 2,280	< 2,210			
S96T000263	123:5	Whole	< 1,990	< 1,770	< 1,880			
S96T000264	123:6	Upper ½	< 2,260	< 2,310	< 2,290			
S96T000265		Lower ½	< 1,880	< 1,810	< 1,850			
S96T000266	123:7	Upper ½	< 1,860	< 1,810	< 1,840			
S96T000267		Lower ½	< 2,340	< 2,180	< 2,260			
S96T000268	123:8	Upper ½	< 1,910	< 1,870	< 1,890			
S96T000269		Lower ½	< 1,810	< 1,870	< 1,840			
S96T000270	123:9	A	< 2,390	< 2,100	< 2,250			
S96T000271		B	< 1,780	< 1,940	< 1,860			
S96T000272		C	< 1,790	< 1,810	< 1,800			
S96T000344	124:2	Whole	< 2,160	< 2,140	< 2,150			
S96T000345	124:3	Whole	< 2,050	< 2,150	< 2,100			
S96T000346	124:4	Whole	< 2,210	< 2,100	< 2,160			
S96T000347	124:5	Upper ½	< 2,410	< 2,500	< 2,460			
S96T000348		Lower ½	< 2,100	< 2,080	< 2,090			

Table A-2. Tank 241-U-109 Analytical Results: Bismuth. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000349	124:6	Upper ½	< 1,950	< 1,820	< 1,890	Cont.	Cont.	Cont.
S96T000350		Lower ½	< 1,830	< 1,860	< 1,850			
S96T000351	124:7	Upper ½	< 2,480	< 2,240	< 2,360			
S96T000352		Lower ½	< 2,230	< 2,040	< 2,140			
S96T000353	124:8	Upper ½	< 2,000	< 1,890	< 1,950			
S96T000354		Lower ½	< 1,970	< 1,750	< 1,860			
S96T000355	124:9	Upper ½	< 2,010	< 1,950	< 1,980			
S96T000356		Lower ½	< 2,070	< 2,160	< 2,120			
S96T000498	128:1	Whole	< 2,070	< 2,140	< 2,110			
S96T000499	128:2	Whole	< 1,940	< 2,070	< 2,010			
S96T000500	128:3	Whole	< 2,300	< 2,310	< 2,310			
S96T000501	128:4	Upper ½	< 2,160	< 2,300	< 2,230			
S96T000502		Lower ½	< 2,140	< 2,050	< 2,100			
S96T000503	128:5	Whole	< 2,060	< 1,960	< 2,010			
S96T000504	128:6	Upper ½	< 2,180	< 1,970	< 2,080			
S96T000505		Lower ½	< 2,230	< 2,210	< 2,220			
S96T000506	128:7	Upper ½	< 2,200	< 2,210	< 2,210			
S96T000507		Lower ½	< 1,880	< 2,150	< 2,020			
S96T000508	128:8	Upper ½	< 2,080	< 2,050	< 2,070			
S96T000509		Lower ½	< 2,270	< 2,380	< 2,330			
S96T000510	128:9	Whole	< 2,210	< 2,130	< 2,170			

Table A-2. Tank 241-U-109 Analytical Results: Bismuth. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Composites: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T001411	123	n/a	< 2,030	< 1,970	< 2,000	< 1,940	N/A	5,680
S96T001658	124	n/a	< 1,940	< 1,950	< 1,950			
S96T001699	128	n/a	< 1,820	< 1,940	< 1,880			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	< 40.10	< 40.1	< 40.1	n/a	n/a	n/a

Table A-3. Tank 241-U-109 Analytical Results: Calcium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000256	123:1	Whole	< 2,540	< 2,130	< 2,340	< 2,110	n/a	6,180
S96T000259	123:2	Whole	< 2,510	< 2,380	< 2,450			
S96T000260	123:3	Upper ½	< 1,900	< 1,980	< 1,940			
S96T000261		Lower ½	< 2,010	< 2,070	< 2,040			
S96T000262	123:4	Whole	< 2,140	< 2,280	< 2,210			
S96T000263	123:5	Whole	< 1,990	< 1,770	< 1,880			
S96T000264	123:6	Upper ½	< 2,260	< 2,310	< 2,290			
S96T000265		Lower ½	< 1,880	< 1,810	< 1,850			

Table A-3. Tank 241-U-109 Analytical Results: Calcium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000266	123:7	Upper ½	< 1,860	< 1,810	< 1,840	Cont.	Cont.	Cont.
S96T000267		Lower ½	< 2,340	< 2,180	< 2,260			
S96T000268	123:8	Upper ½	< 1,910	< 1,870	< 1,890			
S96T000269		Lower ½	< 1,810	< 1,870	< 1,840			
S96T000270	123:9	A	< 2,390	< 2,100	< 2,250			
S96T000271		B	< 1,780	< 1,940	< 1,860			
S96T000272		C	< 1,790	< 1,810	< 1,800			
S96T000344	124:2	Whole	< 2,160	< 2,140	< 2,150			
S96T000345	124:3	Whole	< 2,050	< 2,150	< 2,100			
S96T000346	124:4	Whole	< 2,210	< 2,100	< 2,160			
S96T000347	124:5	Upper ½	< 2,410	< 2,500	< 2,460			
S96T000348		Lower ½	< 2,100	< 2,080	< 2,090			
S96T000349	124:6	Upper ½	< 1,950	< 1,820	< 1,890			
S96T000350		Lower ½	< 1,830	< 1,860	< 1,850			
S96T000351	124:7	Upper ½	< 2,480	< 2,240	< 2,360			
S96T000352		Lower ½	< 2,230	< 2,040	< 2,140			
S96T000353	124:8	Upper ½	< 2,000	< 1,890	< 1,950			
S96T000354		Lower ½	< 1,970	< 1,750	< 1,860			
S96T000355	124:9	Upper ½	< 2,010	< 1,950	< 1,980			
S96T000356		Lower ½	< 2,070	< 2,160	< 2,120			
S96T000498	128:1	Whole	< 2,070	< 2,140	< 2,110			

Table A-3. Tank 241-U-109 Analytical Results: Calcium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000499	128:2	Whole	< 1,940	< 2,070	< 2,010	Cont.	Cont.	Cont.
S96T000500	128:3	Whole	< 2,300	< 2,310	< 2,310			
S96T000501	128:4	Upper ½	< 2,160	< 2,300	< 2,230			
S96T000502		Lower ½	< 2,140	< 2,050	< 2,100			
S96T000503	128:5	Whole	< 2,060	< 1,960	< 2,010			
S96T000504	128:6	Upper ½	< 2,180	< 1,970	< 2,080			
S96T000505		Lower ½	< 2,230	< 2,210	< 2,220			
S96T000506	128:7	Upper ½	< 2,200	< 2,210	< 2,210			
S96T000507		Lower ½	< 1,880	< 2,150	< 2,020			
S96T000508	128:8	Upper ½	< 2,080	< 2,050	< 2,070			
S96T000509		Lower ½	< 2,270	< 2,380	< 2,330			
S96T000510	128:9	Whole	< 2,210	< 2,130	< 2,170			
Composites: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T001411	123	n/a	< 2,030	< 1,970	< 2,000	< 1,940	n/a	5,680
S96T001658	124	n/a	< 1,940	< 1,950	< 1,950			
S96T001699	128	n/a	< 1,820	< 1,940	< 1,880			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	< 40.10	< 40.1	< 40.1	n/a	n/a	n/a

Table A-4. Tank 241-U-109 Analytical Results: Chromium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000256	123:1	Whole	2,890	3,040	2,960	3,690	14.1	10,800
S96T000259	123:2	Whole	1,870	1,750	1,810			
S96T000260	123:3	Upper ½	1,330	1,360	1,340			
S96T000261		Lower ½	1,570	1,390	1,480			
S96T000262	123:4	Whole	2,470	2,490	2,480			
S96T000263	123:5	Whole	3,410	2,510	2,960[QC:e]			
S96T000264	123:6	Upper ½	3,820	3,920	3,870			
S96T000265		Lower ½	3,460	3,530	3,500			
S96T000266	123:7	Upper ½	3,270	3,200	3,240			
S96T000267		Lower ½	3,060	2,320	2,690[QC:e]			
S96T000268	123:8	Upper ½	3,490	3,620	3,560			
S96T000269		Lower ½	3,130	3,310	3,220			
S96T000270	123:9	A	5,490	5,970	5,730			
S96T000271		B	1,990	1,830	1,910			
S96T000272		C	1,240	1,120	1,180			
S96T000344	124:2	Whole	2,640	3,730	3,180[QC:e]			
S96T000345	124:3	Whole	3,190	3,360	3,280			
S96T000346	124:4	Whole	3,040	3,120	3,080			
S96T000347	124:5	Upper ½	4,240	5,510	4,880[QC:e]			
S96T000348		Lower ½	4,310	4,440	4,380			

Table A-4. Tank 241-U-109 Analytical Results: Chromium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000349	124:6	Upper ½	5,310	5,370	5,340	Cont.	Cont.	Cont.
S96T000350		Lower ½	5,280	5,790	5,540			
S96T000351	124:7	Upper ½	3,150	3,220	3,180			
S96T000352		Lower ½	2,350	2,510	2,430			
S96T000353	124:8	Upper ½	4,020	4,180	4,100			
S96T000354		Lower ½	4,940	4,930	4,940			
S96T000355	124:9	Upper ½	4,210	4,180	4,200			
S96T000356		Lower ½	3,090	3,150	3,120			
S96T000498	128:1	Whole	8,790	7,710	8,250			
S96T000499	128:2	Whole	3,260	3,280	3,270			
S96T000500	128:3	Whole	2,660	2,710	2,680			
S96T000501	128:4	Upper ½	2,530	2,520	2,520			
S96T000502		Lower ½	7,560	7,110	7,340			
S96T000503	128:5	Whole	4,280	4,560	4,420			
S96T000504	128:6	Upper ½	5,490	5,510	5,500			
S96T000505		Lower ½	5,000	5,240	5,120			
S96T000506	128:7	Upper ½	5,350	4,850	5,100			
S96T000507		Lower ½	5,780	5,520	5,650			
S96T000508	128:8	Upper ½	3,110	3,020	3,060			
S96T000509		Lower ½	3,850	3,750	3,800			
S96T000510	128:9	Whole	3,020	3,070	3,040			

Table A-4. Tank 241-U-109 Analytical Results: Chromium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: water digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T002846	123:4	Whole	561	652	606.5	553	17.1	1,620
S96T002547	123:6	Lower ½	196	221	208.5			
S96T002847	124:3	Whole	393	366	379.5			
S96T002848	124:8	Upper ½	898	785	841.5			
S96T002546	128:2	Whole	560	532	546			
S96T002849	128:7	Upper ½	726	746	736			
Composites: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T001411	123	n/a	2,570	2,880	2,720	3,590	13.5	10,500
S96T001658	124	n/a	3,610	3,700	3,660			
S96T001699	128	n/a	4,350	4,440	4,400			
Composites: water digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T002515	123	n/a	497	518	507.5	530	2.3	1,550
S96T002516	124	n/a	542	540	541			
S96T002517	128	n/a	505	579	542			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	127	128	127.5	n/a	n/a	n/a

Table A-5. Tank 241-U-109 Analytical Results: Iron. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000256	123:1	Whole	11,500	4,850	8,180[QC:e]	< 1,420	n/a	< 4,160
S96T000259	123:2	Whole	< 1,250	< 1,190	< 1,220			
S96T000260	123:3	Upper ½	< 949	< 989	< 969			
S96T000261		Lower ½	< 1,000	< 1,030	< 1,020			
S96T000262	123:4	Whole	< 1,060	< 1,140	< 1,100			
S96T000263	123:5	Whole	< 993	< 887	< 940			
S96T000264	123:6	Upper ½	< 1,130	< 1,170	< 1,150			
S96T000265		Lower ½	< 942	< 905	< 924			
S96T000266	123:7	Upper ½	< 932	< 906	< 919			
S96T000267		Lower ½	< 1,170	< 1,080	< 1,130			
S96T000268	123:8	Upper ½	< 955	< 933	< 944			
S96T000269		Lower ½	< 907	< 933	< 920			
S96T000270	123:9	A	1,260	1,280	1,270			
S96T000271		B	< 891	< 968	< 930			
S96T000272		C	< 888	< 906	< 897			
S96T000344	124:2	Whole	1,380	1,880	1,630[QC:e]			
S96T000345	124:3	Whole	< 1,030	< 1,090	< 1,060			
S96T000346	124:4	Whole	< 1,100	< 1,050	< 1,080			
S96T000347	124:5	Upper ½	< 1,200	< 1,250	< 1,230			
S96T000348		Lower ½	< 1,050	< 1,040	< 1,050			

Table A-5. Tank 241-U-109 Analytical Results: Iron. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000349	124:6	Upper ½	< 973	< 911	< 942	Cont.	Cont.	Cont.
S96T000350		Lower ½	< 916	< 931	< 924			
S96T000351	124:7	Upper ½	< 1,240	< 1,120	< 1,180			
S96T000352		Lower ½	< 1,120	< 1,020	< 1,070			
S96T000353	124:8	Upper ½	< 999	< 943	< 971			
S96T000354		Lower ½	< 984	< 877	< 931			
S96T000355	124:9	Upper ½	< 1,000	< 973	< 987			
S96T000356		Lower ½	< 1,030	< 1,080	< 1,060			
S96T000498	128:1	Whole	1,380	2,620	2,000[QC:e]			
S96T000499	128:2	Whole	< 972	< 1,050	< 1,010			
S96T000500	128:3	Whole	< 1,150	< 1,170	< 1,160			
S96T000501	128:4	Upper ½	< 1,080	< 1,150	< 1,120			
S96T000502		Lower ½	< 1,070	< 1,030	< 1,050			
S96T000503	128:5	Whole	< 1,030	< 981	< 1,010			
S96T000504	128:6	Upper ½	< 1,090	< 987	< 1,040			
S96T000505		Lower ½	< 1,120	< 1,100	< 1,110			
S96T000506	128:7	Upper ½	< 1,100	< 1,110	< 1,110			
S96T000507		Lower ½	< 940	< 1,070	< 1,010			
S96T000508	128:8	Upper ½	< 1,040	< 1,020	< 1,030			
S96T000509		Lower ½	< 1,130	< 1,190	< 1,160			
S96T000510	128:9	Whole	3,640	< 1,070	2,360			

Table A-5. Tank 241-U-109 Analytical Results: Iron. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Composites: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T001411	123	n/a	< 1,010	< 987	< 999	< 971	n/a	< 2,840
S96T001658	124	n/a	< 971	< 975	< 973			
S96T001699	128	n/a	< 911	< 972	< 942			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	< 20.00	< 20.0	< 20.0	n/a	n/a	n/a

Table A-6. Tank 241-U-109 Analytical Results: Manganese. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000256	123:1	Whole	< 254	< 213	< 234	< 216	n/a	< 632
S96T000259	123:2	Whole	< 251	< 238	< 245			
S96T000260	123:3	Upper ½	< 190	< 198	< 194			
S96T000261		Lower ½	< 201	< 207	< 204			
S96T000262	123:4	Whole	< 214	< 228	< 221			
S96T000263	123:5	Whole	< 199	< 177	< 188			
S96T000264	123:6	Upper ½	< 226	< 231	< 229			
S96T000265		Lower ½	< 188	< 181	< 185			
S96T000266	123:7	Upper ½	< 186	< 181	< 184			
S96T000267		Lower ½	< 234	< 218	< 226			

Table A-6. Tank 241-U-109 Analytical Results: Manganese. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000268	123:8	Upper ½	< 191	< 187	< 189	Cont.	Cont.	Cont.
S96T000269		Lower ½	< 181	< 187	< 184			
S96T000270	123:9	A	521	580	550.5			
S96T000271		B	< 178	< 194	< 186			
S96T000272		C	< 179	< 181	< 180			
S96T000344	124:2	Whole	< 216	< 214	< 215			
S96T000345	124:3	Whole	< 205	< 215	< 210			
S96T000346	124:4	Whole	< 221	< 210	< 216			
S96T000347	124:5	Upper ½	< 241	< 250	< 246			
S96T000348		Lower ½	< 210	< 208	< 209			
S96T000349	124:6	Upper ½	< 195	< 182	< 189			
S96T000350		Lower ½	< 183	< 186	< 185			
S96T000351	124:7	Upper ½	< 248	< 224	< 236			
S96T000352		Lower ½	< 223	< 204	< 214			
S96T000353	124:8	Upper ½	< 200	< 189	< 195			
S96T000354		Lower ½	< 197	< 175	< 186			
S96T000355	124:9	Upper ½	< 201	< 195	< 198			
S96T000356		Lower ½	236	251	243.5			
S96T000498	128:1	Whole	226	< 214	220			
S96T000499	128:2	Whole	< 194	< 207	< 201			
S96T000500	128:3	Whole	< 230	< 231	< 231			

Table A-6. Tank 241-U-109 Analytical Results: Manganese. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000501	128:4	Upper ½	< 216	< 230	< 223	Cont.	Cont.	Cont.
S96T000502		Lower ½	< 214	< 205	< 210			
S96T000503	128:5	Whole	< 206	< 196	< 201			
S96T000504	128:6	Upper ½	< 218	< 197	< 208			
S96T000505		Lower ½	< 223	< 221	< 222			
S96T000506	128:7	Upper ½	< 220	< 221	< 221			
S96T000507		Lower ½	< 188	< 215	< 202			
S96T000508	128:8	Upper ½	< 208	< 205	< 207			
S96T000509		Lower ½	< 227	< 238	< 233			
S96T000510	128:9	Whole	< 221	< 213	< 217			
Composites: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T001411	123	n/a	< 203	< 197	< 200	< 194	n/a	< 568
S96T001658	124	n/a	< 194	< 195	< 195			
S96T001699	128	n/a	< 182	< 194	< 188			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	< 4.010	< 4.01	< 4.01	n/a	n/a	n/a

Table A-7. Tank 241-U-109 Analytical Results: Nickel. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000256	123:1	Whole	< 508	< 426	< 467	< 421	n/a	< 1,230
S96T000259	123:2	Whole	< 502	< 477	< 490			
S96T000260	123:3	Upper ½	< 380	< 397	< 389			
S96T000261		Lower ½	< 401	< 414	< 408			
S96T000262	123:4	Whole	< 425	< 457	< 441			
S96T000263	123:5	Whole	< 397	< 355	< 376			
S96T000264	123:6	Upper ½	< 452	< 462	< 457			
S96T000265		Lower ½	< 377	< 362	< 370			
S96T000266	123:7	Upper ½	< 373	< 362	< 368			
S96T000267		Lower ½	< 468	< 433	< 451			
S96T000268	123:8	Upper ½	< 382	< 373	< 378			
S96T000269		Lower ½	< 363	< 373	< 368			
S96T000270	123:9	A	< 477	< 419	< 448			
S96T000271		B	< 356	< 387	< 372			
S96T000272		C	< 355	< 362	< 359			
S96T000344	124:2	Whole	< 432	< 428	< 430			
S96T000345	124:3	Whole	< 411	< 430	< 421			
S96T000346	124:4	Whole	< 442	< 419	< 431			
S96T000347	124:5	Upper ½	< 481	< 500	< 491			
S96T000348		Lower ½	< 411	< 416	< 414			

Table A-7. Tank 241-U-109 Analytical Results: Nickel. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000350		Lower ½	< 366	< 374	< 370	Cont.	Cont.	Cont.
S96T000351	124:7	Upper ½	< 495	< 448	< 472			
S96T000352		Lower ½	< 446	< 408	< 427			
S96T000353	124:8	Upper ½	< 400	< 377	< 389			
S96T000354		Lower ½	< 394	< 351	< 373			
S96T000355	124:9	Upper ½	< 401	< 389	< 395			
S96T000356		Lower ½	< 413	< 432	< 423			
S96T000498	128:1	Whole	< 413	< 428	< 421			
S96T000499	128:2	Whole	< 389	< 414	< 402			
S96T000500	128:3	Whole	< 460	< 462	< 461			
S96T000501	128:4	Upper ½	< 432	< 459	< 446			
S96T000502		Lower ½	< 427	< 410	< 419			
S96T000503	128:5	Whole	< 412	< 394	< 403			
S96T000504	128:6	Upper ½	< 437	< 395	< 416			
S96T000505		Lower ½	< 447	< 441	< 444			
S96T000506	128:7	Upper ½	< 431	< 442	< 437			
S96T000507		Lower ½	< 376	< 430	< 403			
S96T000508	128:8	Upper ½	< 417	< 409	< 413			
S96T000509		Lower ½	< 454	< 476	< 465			
S96T000510	128:9	Whole	< 441	< 427	< 434			

Table A-7. Tank 241-U-109 Analytical Results: Nickel. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Composites: fusion digest			**μg/g**	**μg/g**	**μg/g**	**μg/g**	**%**	**kg**
S96T001411	123	n/a	1,680	567	1,120[QC:e]	1,840	30.7	5,390
S96T001658	124	n/a	2,960	2,970	2,960			
S96T001699	128	n/a	2,260	642	1,450			
Liquids: direct			**μg/mL**	**μg/mL**	**μg/mL**	**μg/mL**	**%**	**kg**
S96T000280	124:3	DL	< 8.020	< 8.02	< 8.02	n/a	n/a	n/a

Table A-8. Tank 241-U-109 Analytical Results: Phosphorus. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**μg/g**	**μg/g**	**μg/g**	**μg/g**	**%**	**kg**
S96T000256	123:1	Whole	< 5,080	< 4,260	< 4,670	< 8,000	n/a	< 23,400
S96T000259	123:2	Whole	< 5,020	< 4,770	< 4,900			
S96T000260	123:3	Upper ½	< 3,800	< 3,970	< 3,890			
S96T000261		Lower ½	< 4,010	< 4,140	< 4,080			
S96T000262	123:4	Whole	< 4,250	< 4,570	< 4,410			
S96T000263	123:5	Whole	< 3,970	< 3,550	< 3,760			
S96T000264	123:6	Upper ½	< 4,520	< 4,620	< 4,570			
S96T000265		Lower ½	< 3,770	< 3,620	< 3,700			
S96T000266	123:7	Upper ½	< 3,730	< 3,620	< 3,680			
S96T000267		Lower ½	< 4,680	< 4,330	< 4,510			

Table A-8. Tank 241-U-109 Analytical Results: Phosphorus. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			μg/g	μg/g	μg/g	μg/g	%	kg
S96T000268	123:8	Upper ½	< 3,820	< 3,730	< 3,780[QC:d]	Cont.	Cont.	Cont.
S96T000269		Lower ½	< 3,630	< 3,730	< 3,680			
S96T000270	123:9	A	39,300	43,500	41,400			
S96T000271		B	8,060	6,530	7,300[QC:e]			
S96T000272		C	< 3,550	< 3,620	< 3,590			
S96T000344	124:2	Whole	7,420	8,150	7,780			
S96T000345	124:3	Whole	< 4,110	< 4,300	< 4,210			
S96T000346	124:4	Whole	< 4,420	< 4,190	< 4,310			
S96T000347	124:5	Upper ½	< 4,810	< 5,000	< 4,910			
S96T000348		Lower ½	< 4,110	< 4,160	< 4,140			
S96T000349	124:6	Upper ½	< 3,890	< 3,640	< 3,770			
S96T000350		Lower ½	< 3,660	< 3,740	< 3,700			
S96T000351	124:7	Upper ½	< 4,950	< 4,480	< 4,720			
S96T000352		Lower ½	< 4,460	< 4,080	< 4,270			
S96T00053	12:48	Upper ½	< 4,000	< 3,770	< 3,890[QC:d]			
S96T000354		Lower ½	< 3,940	< 3,510	< 3,730			
S96T000355	124:9	Upper ½	30,000	29,400	29,700			
S96T000356		Lower ½	54,200	60,400	57,300			
S96T000498	128:1	Whole	< 4,130	< 4,280	< 4,210[QC:d]			
S96T000499	128:2	Whole	< 3,890	< 4,140	< 4,020			
S96T000500	128:3	Whole	< 4,600	< 4,620	< 4,610			

Table A-8. Tank 241-U-109 Analytical Results: Phosphorus. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000501	128:4	Upper ½	< 4,320	< 4,590	< 4,460	Cont.	Cont.	Cont.
S96T000502		Lower ½	8,640	7,240	7,940			
S96T000503	128:5	Whole	< 4,120	< 3,940	< 4,030			
S96T000504	128:6	Upper ½	< 4,370	< 3,950	< 4,160			
S96T000505		Lower ½	< 4,470	< 4,410	< 4,440			
S96T000506	128:7	Upper ½	< 4,310	< 4,420	< 4,370			
S96T000507		Lower ½	< 3,760	< 4,300	< 4,030			
S96T000508	128:8	Upper ½	< 4,170	< 4,090	< 4,130			
S96T000509		Lower ½	11,600	9,020	10,300[QC:e]			
S96T000510	128:9	Whole	40,200	40,000	40,100			
Composites: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T001411	123	n/a	4,260	5,720	4,990	6,320	12.4	18,500
S96T001658	124	n/a	6,000	6,570	6,280			
S96T001699	128	n/a	7,580	7,810	7,700			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	839	838	838.5	n/a	n/a	n/a

Table A-9. Tank 241-U-109 Analytical Results: Silicon. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000256	123:1	Whole	1,650	1,820	1,740	< 1,150	n/a	< 3,370
S96T000259	123:2	Whole	1,250	< 1,190	1,220			
S96T000260	123:3	Upper ½	< 949	< 989	< 969			
S96T000261		Lower ½	< 1,000	< 1,030	< 1,020			
S96T000262	123:4	Whole	< 1,060	< 1,140	< 1,100			
S96T000263	123:5	Whole	< 993	< 887	< 940			
S96T000264	123:6	Upper ½	< 1,130	< 1,170	< 1,150			
S96T000265		Lower ½	< 942	< 905	< 924			
S96T000266	123:7	Upper ½	< 932	< 906	< 919			
S96T000267		Lower ½	< 1,170	< 1,080	< 1,130			
S96T000268	123:8	Upper ½	< 955	< 933	< 944			
S96T000269		Lower ½	< 907	< 933	< 920			
S96T000270	123:9	A	1,580	1,600	1,590			
S96T000271		B	< 891	< 968	< 930			
S96T000272		C	< 888	< 906	< 897			
S96T000344	124:2	Whole	< 1,080	< 1,070	< 1,080			
S96T000345	124:3	Whole	< 1,030	< 1,090	< 1,060			
S96T000346	124:4	Whole	< 1,100	< 1,050	< 1,080			
S96T000347	124:5	Upper ½	< 1,200	< 1,250	< 1,230			
S96T000348		Lower ½	< 1,050	< 1,040	< 1,050			

Table A-9. Tank 241-U-109 Analytical Results: Silicon. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000349	124:6	Upper ½	< 973	< 911	< 942	Cont.	Cont.	Cont.
S96T000350		Lower ½	< 916	< 931	< 924			
S96T000351	124:7	Upper ½	< 1,240	< 1,120	< 1,180			
S96T000352		Lower ½	< 1,120	< 1,020	< 1,070			
S96T000353	124:8	Upper ½	< 999	< 943	< 971			
S96T000354		Lower ½	< 984	< 877	< 931			
S96T000355	124:9	Upper ½	< 1,000	< 973	< 987			
S96T000356		Lower ½	< 1,030	< 1,080	< 1,060			
S96T000498	128:1	Whole	< 1,030	< 1,070	< 1,050			
S96T000499	128:2	Whole	< 972	< 1,050	< 1,010			
S96T000500	128:3	Whole	< 1,150	< 1,170	< 1,160			
S96T000501	128:4	Upper ½	< 1,080	< 1,150	< 1,120			
S96T000502		Lower ½	< 1,070	< 1,030	< 1,050			
S96T000503	128:5	Whole	< 1,030	< 981	< 1,010			
S96T000504	128:6	Upper ½	< 1,090	< 987	< 1,040			
S96T000505		Lower ½	< 1,120	< 1,100	< 1,110			
S96T000506	128:7	Upper ½	< 1,100	< 1,110	< 1,110			
S96T000507		Lower ½	< 940	< 1,070	< 1,010			
S96T000508	128:8	Upper ½	< 1,040	< 1,020	< 1,030			
S96T000509		Lower ½	< 1,130	< 1,190	< 1,160			
S96T000510	128:9	Whole	2,840	3,270	3,060			

Table A-9. Tank 241-U-109 Analytical Results: Silicon. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Composites: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T001411	123	n/a	< 1,010	< 987	< 999	< 1,580	n/a	< 4,630
S96T001658	124	n/a	4,530	< 975	2,750			
S96T001699	128	n/a	< 911	1,050	981			
Liquids: direct			µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000280	124:3	DL	56.70	57.00	56.85	n/a	n/a	n/a

Table A-10. Tank 241-U-109 Analytical Results: Sodium. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000256	123:1	Whole	2.14E+05	2.22E+05	2.18E+05	2.21E+05	3.0	6.47E+05
S96T000259	123:2	Whole	2.40E+05	2.31E+05	2.36E+05			
S96T000260	123:3	Upper ½	2.27E+05	2.29E+05	2.28E+05			
S96T000261		Lower ½	2.42E+05	2.41E+05	2.42E+05[QC:d]			
S96T000262	123:4	Whole	2.30E+05	2.33E+05	2.32E+05			
S96T000263	123:5	Whole	2.40E+05	2.27E+05	2.34E+05			
S96T000264	123:6	Upper ½	2.07E+05	2.12E+05	2.10E+05			
S96T000265		Lower ½	2.14E+05	2.08E+05	2.11E+05			
S96T000266	123:7	Upper ½	2.28E+05	2.29E+05	2.28E+05			
S96T000267		Lower ½	2.50E+05	2.29E+05	2.40E+05[QC:d]			

Table A-10. Tank 241-U-109 Analytical Results: Sodium. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000268	123:8	Upper ½	2.11E+05	2.27E+05	2.19E+05	Cont.	Cont.	Cont.
S96T000269		Lower ½	2.26E+05	2.22E+05	2.24E+05			
S96T000270	123:9	A	2.06E+05	2.05E+05	2.06E+05			
S96T000271		B	7.34E+04	7.57E+04	7.46E+04			
S96T000272		C	5.71E+04	6.11E+04	5.91E+04			
S96T000344	124:2	Whole	2.51E+05	2.50E+05	2.50E+05[QC:c]			
S96T000345	124:3	Whole	2.23E+05	2.09E+05	2.16E+05[QC:c]			
S96T000346	124:4	Whole	2.54E+05	2.56E+05	2.55E+05[QC:c]			
S96T000347	124:5	Upper ½	2.35E+05	2.39E+05	2.37E+05[QC:c]			
S96T000348		Lower ½	2.29E+05	2.34E+05	2.32E+05[QC:c]			
S96T000349	124:6	Upper ½	2.20E+05	2.20E+05	2.20E+05[QC:c]			
S96T000350		Lower ½	2.17E+05	2.16E+05	2.16E+05[QC:c]			
S96T000351	124:7	Upper ½	2.29E+05	2.28E+05	2.28E+05[QC:c]			
S96T000352		Lower ½	2.36E+05	2.31E+05	2.34E+05			
S96T000353	124:8	Upper ½	2.27E+05	2.29E+05	2.28E+05[QC:c]			
S96T000354		Lower ½	2.18E+05	2.16E+05	2.17E+05			
S96T000355	124:9	Upper ½	2.20E+05	2.24E+05	2.22E+05[QC:c]			
S96T000356		Lower ½	1.87E+05	1.95E+05	1.91E+05[QC:c]			
S96T000498	128:1	Whole	2.31E+05	2.49E+05	2.40E+05			
S96T000499	128:2	Whole	2.48E+05	2.44E+05	2.46E+05			
S96T000500	128:3	Whole	2.53E+05	2.55E+05	2.54E+05[QC:c]			

Table A-10. Tank 241-U-109 Analytical Results: Sodium. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000501	128:4	Upper ½	2.45E+05	2.48E+05	2.46E+05	Cont.	Cont.	Cont.
S96T000502		Lower ½	2.03E+05	2.02E+05	2.02E+05[QC:c]			
S96T000503	128:5	Whole	2.20E+05	2.12E+05	2.16E+05[QC:c]			
S96T000504	128:6	Upper ½	2.10E+05	2.03E+05	2.06E+05[QC:c]			
S96T000505		Lower ½	2.12E+05	2.14E+05	2.13E+05[QC:c]			
S96T000506	128:7	Upper ½	2.05E+05	2.17E+05	2.11E+05[QC:c]			
S96T000507		Lower ½	1.87E+05	1.97E+05	1.92E+05[QC:c]			
S96T000508	128:8	Upper ½	2.29E+05	2.30E+05	2.30E+05[QC:c]			
S96T000509		Lower ½	2.24E+05	2.25E+05	2.24E+05[QC:c]			
S96T000510	128:9	Whole	1.49E+05	1.52E+05	1.50E+05[QC:c]			
Solids: water digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T002846	123:4	Whole	2.48E+05	2.84E+05	2.66E+05[QC:d]	2.50E+05	4.9	7.32E+05
S96T002547	123:6	Lower ½	2.49E+05	3.15E+05	2.82E+05[QC:d,e]			
S96T002847	124:3	Whole	2.32E+05	2.24E+05	2.28E+05			
S96T002848	124:8	Upper ½	2.40E+05	2.36E+05	2.38E+05[QC:d]			
S96T002546	128:2	Whole	2.59E+05	2.56E+05	2.58E+05			
S96T002849	128:7	Upper ½	2.35E+05	2.23E+05	2.29E+05			
Composites: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T001411	123	n/a	2.28E+05	2.28E+05	2.28E+05	2.27E+05	2.1	6.65E+05
S96T001658	124	n/a	2.34E+05	2.34E+05	2.34E+05			
S96T001699	128	n/a	2.17E+05	2.19E+05	2.18E+05			

Table A-10. Tank 241-U-109 Analytical Results: Sodium. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Composites: water digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T002515	123	n/a	2.45E+05	2.37E+05	2.41E+05	2.38E+05	2.0	6.97E+05
S96T002516	124	n/a	2.43E+05	2.44E+05	2.44E+05			
S96T002517	128	n/a	2.34E+05	2.23E+05	2.28E+05			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	1.77E+05	1.76E+05	1.76E+05	n/a	n/a	n/a

Table A-11. Tank 241-U-109 Analytical Results: Uranium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000256	123:1	Whole	< 12,700	< 10,800	< 11,800	< 10,600	n/a	< 31,000
S96T000259	123:2	Whole	< 12,500	< 11,900	< 12,200			
S96T000260	123:3	Upper ½	< 9,490	< 9,890	< 9,690			
S96T000261		Lower ½	< 10,000	< 10,300	< 10,200			
S96T000262	123:4	Whole	< 10,600	< 11,400	< 11,000			
S96T000263	123:5	Whole	< 9,930	< 8,870	< 9,400			
S96T000264	123:6	Upper ½	< 11,300	< 11,700	< 11,500			
S96T000265		Lower ½	< 9,420	< 9,050	< 9,240			
S96T000266	123:7	Upper ½	< 9,320	< 9,060	< 9,190			
S96T000267		Lower ½	< 11,700	< 10,800	< 11,300			

Table A-11. Tank 241-U-109 Analytical Results: Uranium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000268	123:8	Upper ½	< 9,550	< 9,330	< 9,440	Cont.	Cont.	Cont.
S96T000269		Lower ½	< 9,070	< 9,330	< 9,200			
S96T000270	123:9	A	< 11,900	< 10,500	< 11,200			
S96T000271		B	< 8,910	< 9,680	< 9,300			
S96T000272		C	11,300	14,100	12,700[QC:e]			
S96T000344	124:2	Whole	< 10,800	< 10,700	< 10,800			
S96T000345	124:3	Whole	< 10,300	< 10,900	< 10,600			
S96T000346	124:4	Whole	< 11,000	< 10,500	< 10,800			
S96T000347	124:5	Upper ½	< 12,000	< 12,500	< 12,300			
S96T000348		Lower ½	< 10,500	< 10,400	< 10,500			
S96T000349	124:6	Upper ½	< 9,730	< 9,110	< 9,420			
S96T000350		Lower ½	< 9,160	< 9,310	< 9,240			
S96T000351	124:7	Upper ½	< 12,400	< 11,200	< 11,800			
S96T000352		Lower ½	< 11,200	< 10,200	< 10,700			
S96T000353	124:8	Upper ½	< 9,990	< 9,430	< 9,710			
S96T000354		Lower ½	< 9,840	< 8,770	< 9,310			
S96T000355	124:9	Upper ½	< 10,000	< 9,730	< 9,870			
S96T000356		Lower ½	< 10,300	< 10,800	< 10,600			
S96T000498	128:1	Whole	< 10,300	< 10,700	< 10,500			
S96T000499	128:2	Whole	< 9,720	< 10,500	< 10,100			
S96T000500	128:3	Whole	< 11,500	< 11,700	< 11,600			

Table A-11. Tank 241-U-109 Analytical Results: Uranium. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000501	128:4	Upper ½	< 10,800	< 11,500	< 11,200	Cont.	Cont.	Cont.
S96T000502		Lower ½	< 10,700	< 10,300	< 10,500			
S96T000503	128:5	Whole	< 10,300	< 9,810	< 10,100			
S96T000504	128:6	Upper ½	< 10,900	< 9,870	< 10,400			
S96T000505		Lower ½	< 11,200	< 11,000	< 11,100			
S96T000506	128:7	Upper ½	< 11,000	< 11,100	< 11,100			
S96T000507		Lower ½	< 9,400	< 10,700	< 10,100			
S96T000508	128:8	Upper ½	< 10,400	< 10,200	< 10,300			
S96T000509		Lower ½	< 11,300	< 11,900	< 11,600			
S96T000510	128:9	Whole	< 11,000	< 10,700	< 10,900			
Composites: ICP (fusion digest)			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T001411	123	n/a	< 10,100	< 9,870	< 9,990	< 9,710	n/a	< 28,400
S96T001658	124	n/a	< 9,710	< 9,750	< 9,730			
S96T001699	128	n/a	< 9,110	< 9,720	< 9,420			
Composites: phosphorescence (fusion digest)								
S96T001411	123	n/a	697	761.0	729.0	428	35.3	1,250
S96T001658	124	n/a	270	256.0	263.0			
S96T001699	128	n/a	284	298.0	291.0			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	< 200	< 200	< 200	n/a	n/a	n/a

Table A-12. Tank 241-U-109 Analytical Results: Chloride.

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct			µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000280	124:3	DL	3,540	3,580	3,560	n/a	n/a	n/a

Table A-13. Tank 241-U-109 Analytical Results: Fluoride.

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct			µg/mL	µg/mL	µg/mL	µg/mL	%	kg
S96T000280	124:3	DL	374	223	298.4[QC:e]	n/a	n/a	n/a

Table A-14. Tank 241-U-109 Analytical Results: Nitrate. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: water digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000229	123:1	Whole	3.50E+05	4.02E+05	3.76E+05[QC:e]	3.08E+05	12.8	9.02E+05
S96T000230	123:2	Whole	2.22E+05	2.54E+05	2.38E+05			
S96T000231	123:3	Upper ½	5.92E+05	5.80E+05	5.86E+05[QC:e]			
S96T000232		Lower ½	5.90E+05	5.95E+05	5.92E+05			
S96T000233	123:4	Whole	5.86E+05	6.01E+05	5.94E+05			
S96T000234	123:5	Whole	4.80E+05	5.38E+05	5.09E+05			

Table A-14. Tank 241-U-109 Analytical Results: Nitrate. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: water digest			µg/g	µg/g	µg/g	µg/g	%	kg
S96T000235	123:6	Upper ½	2.64E+05	3.06E+05	2.85E+05	Cont.	Cont.	Cont.
S96T000236		Lower ½	3.11E+05	2.89E+05	3.00E+05			
S96T000237	123:7	Upper ½	4.13E+05	4.16E+05	4.15E+05[QC:c]			
S96T000238		Lower ½	4.89E+05	4.74E+05	4.82E+05			
S96T000239	123:8	Upper ½	3.33E+05	3.34E+05	3.34E+05			
S96T000240		Lower ½	3.59E+05	3.57E+05	3.58E+05			
S96T000241	123:9	A	1.05E+05	1.06E+05	1.06E+05			
S96T000242		B	42,700	46,200	44,500[QC:d]			
S96T000243		C	51,600	48,400	50,000			
S96T000357	124:2	Whole	2.85E+05	2.68E+05	2.76E+05			
S96T000358	124:3	Whole	2.88E+05	2.83E+05	2.85E+05			
S96T000359	124:4	Whole	4.01E+05	4.30E+05	4.16E+05			
S96T000360	124:5	Upper ½	3.96E+05	3.99E+05	3.98E+05			
S96T000361		Lower ½	2.86E+05	3.01E+05	2.93E+05			
S96T000362	124:6	Upper ½	1.60E+05	1.77E+05	1.69E+05			
S96T000363		Lower ½	1.48E+05	1.61E+05	1.55E+05			
S96T000364	124:7	Upper ½	3.92E+05	3.81E+05	3.86E+05			
S96T000365		Lower ½	4.58E+05	4.41E+05	4.49E+05			
S96T000366	124:8	Upper ½	3.28E+05	3.38E+05	3.33E+05			
S96T000367		Lower ½	2.87E+05	2.86E+05	2.86E+05			

Table A-14. Tank 241-U-109 Analytical Results: Nitrate. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: water digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T000368	124:9	Upper ½	1.04E+05	87,800	95,700	Cont.	Cont.	Cont.
S96T000369		Lower ½	38,900	46,800	42,800			
S96T000511	128:1	Whole	1.41E+05	1.95E+05	1.68E+05[QC:e]			
S96T000512	128:2	Whole	4.46E+05	4.67E+05	4.56E+05			
S96T000513	128:3	Whole	5.19E+05	4.61E+05	4.90E+05			
S96T000514	128:4	Upper ½	4.92E+05	3.04E+05	3.98E+05[QC:e]			
S96T000515		Lower ½	1.20E+05	1.67E+05	1.44E+05[QC:e]			
S96T000516	128:5	Whole	2.57E+05	2.55E+05	2.56E+05[QC:e]			
S96T000517	128:6	Upper ½	1.42E+05	1.79E+05	1.60E+05[QC:e]			
S96T000518		Lower ½	1.91E+05	1.80E+05	1.85E+05			
S96T000519	128:7	Upper ½	1.96E+05	2.16E+05	2.06E+05			
S96T000520		Lower ½	1.06E+05	1.05E+05	1.06E+05			
S96T000521	128:8	Upper ½	3.45E+05	3.50E+05	3.48E+05			
S96T000522		Lower ½	1.99E+05	2.60E+05	2.29E+05[QC:c,e]			
S96T000523	128:9	Whole	30,800	32,700	31,800			
Composites: water digest			**µg/g**	**µg/g**	**µg/g**	**µg/g**	**%**	**kg**
S96T001412	123	n/a	4.37E+05	4.65E+05	4.51E+05	3.31E+05	18.4	9.69E+05
S96T001659	124	n/a	3.01E+05	2.71E+05	2.86E+05			
S96T001700	128	n/a	2.65E+05	2.46E+05	2.55E+05			
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**	**µg/mL**	**%**	**kg**
S96T000280	124:3	DL	3.64E+05	3.55E+05	3.59E+05	n/a	n/a	n/a

Table A-15. Tank 241-U-109 Analytical Results: Nitrite.

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct			μg/mL	μg/mL	μg/mL	μg/mL	%	kg
S96T000280	124:3	DL	43,900	41,900	42,900	n/a	n/a	n/a

Table A-16. Tank 241-U-109 Analytical Results: Oxalate.

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct			μg/mL	μg/mL	μg/mL	μg/mL	%	kg
S96T000280	124:3	DL	< 1,070	< 1,070	< 1,070	n/a	n/a	n/a

Table A-17. Tank 241-U-109 Analytical Results: Phosphate.

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct			μg/mL	μg/mL	μg/mL	μg/mL	%	kg
S96T000280	124:3	DL	5,850	6,090	5,970	n/a	n/a	n/a

Table A-18. Tank 241-U-109 Analytical Results: Sulfate.

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Liquids: direct			μg/mL	μg/mL	μg/mL	μg/mL	%	kg
S96T000280	124:3	DL	11,200	11,000	11,100	n/a	n/a	n/a

Table A-19. Tank 241-U-109 Analytical Results: Cesium-137. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µCi/g	µCi/g	µCi/g	µCi/g	%	Ci
S96T000256	123:1	Whole	85.48	82.6	84.04	112	9.8	3.28E+05
S96T000259	123:2	Whole	92.43	90.7	91.56			
S96T000260	123:3	Upper ½	48.8	48.2	48.5			
S96T000261		Lower ½	51.87	44.3	48.08			
S96T000262	123:4	Whole	85.01	50	67.5[QC:e]			
S96T000263	123:5	Whole	101	113	106.9			
S96T000264	123:6	Upper ½	156	154	155.2			
S96T000265		Lower ½	147	136	141.6			
S96T000266	123:7	Upper ½	105	103	104			
S96T000267		Lower ½	113	94	103.5			
S96T000268	123:8	Upper ½	103	112	107.5			
S96T000269		Lower ½	120	112	115.9			
S96T000270	123:9	A	68.07	67.5	67.78			
S96T000271		B	66.92	70.4	68.66			
S96T000272		C	81.86	78.7	80.28			
S96T000344	124:2	Whole	58.97	62.6	60.78			
S96T000345	124:3	Whole	90.72	105	97.86			
S96T000346	124:4	Whole	74.32	78.2	76.26			
S96T000347	124:5	Upper ½	115	135	125			
S96T000348		Lower ½	159	157	157.8			

Table A-19. Tank 241-U-109 Analytical Results: Cesium-137. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µCi/g	µCi/g	µCi/g	µCi/g	%	Ci
S96T000349	124:6	Upper ½	196	195	195.6	Cont.	Cont.	Cont.
S96T000350		Lower ½	198	214	205.8			
S96T000351	124:7	Upper ½	108	124	116			
S96T000352		Lower ½	95.8	100	97.9			
S96T000353	124:8	Upper ½	136	142	139			
S96T000354		Lower ½	157	153	155			
S96T000355	124:9	Upper ½	122	112	117.2			
S96T000356		Lower ½	60.96	59.1	60.03			
S96T000498	128:1	Whole	141	126	133.3			
S96T000499	128:2	Whole	94.37	94.9	94.64			
S96T000500	128:3	Whole	86.42	87.4	86.91			
S96T000501	128:4	Upper ½	98.42	91.8	95.11			
S96T000502		Lower ½	194	196	195.2			
S96T000503	128:5	Whole	147	158	152.4			
S96T000504	128:6	Upper ½	170	188	178.9			
S96T000505		Lower ½	164	164	164			
S96T000506	128:7	Upper ½	172	159	165.2			
S96T000507		Lower ½	186	203	194.4			
S96T000508	128:8	Upper ½	113	108	110.4			
S96T000509		Lower ½	137	128	132.3			
S96T000510	128:9	Whole	65.11	67.1	66.1			

Table A-19. Tank 241-U-109 Analytical Results: Cesium-137. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Composites: fusion digest			µCi/g	µCi/g	µCi/g	µCi/g	%	Ci
S96T001411	123	n/a	99.33	96.8	98.06	122	10.8	3.57E+05
S96T001658	124	n/a	126	124	125			
S96T001699	128	n/a	144	143	143.7			

Table A-20. Tank 241-U-109 Analytical Results: Strontium-89/90.

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µCi/g	µCi/g	µCi/g	µCi/g	%	Ci
S96T000262	123:4	Whole	3.71	3.3	3.505	6.89	15.4	20,200
S96T000265	123:6	Lower ½	7.16	7.69	7.425			
S96T000345	124:3	Whole	5.99	6.26	6.125			
S96T000353	124:8	Upper ½	8.94	8.85	8.895			
S96T000499	128:2	Whole	4.71	4.96	4.835			
S96T000506	128:7	Upper ½	11.3	9.79	10.54			
Composites: fusion digest			µCi/g	µCi/g	µCi/g	µCi/g	%	Ci
S96T001411	123	n/a	7.66	8.11	7.885	9.70	10.1	28,400
S96T001658	124	n/a	9.8	10.1	9.95			
S96T001699	128	n/a	11.1	11.4	11.25			

Table A-21. Tank 241-U-109 Analytical Results: Total Alpha. (2 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			µCi/g	µCi/g	µCi/g	µCi/g	%	Ci
S96T000256	123:1	Whole	0.0236	0.0267	0.0251[QC:e]	0.0371	20.9	109
S96T000259	123:2	Whole	0.0157	0.0222	0.0190[QC:c,e]			
S96T000260	123:3	Upper ½	0.0124	0.0129	0.0126			
S96T000261		Lower ½	0.0124	0.00540	0.00890[QC:e]			
S96T000262	123:4	Whole	0.0553	0.0302	0.0428[QC:e]			
S96T000263	123:5	Whole	0.0324	0.0261	0.0292[QC:e]			
S96T000265	123:6	Lower ½	0.0282	0.0292	0.0287			
S96T000267	123:7	Lower ½	0.0163	0.0110	0.0136[QC:c,e]			
S96T000269	123:8	Lower ½	0.0158	0.0160	0.0159			
S96T000272	123:9	C	0.0114	0.0114	0.0114[QC:e]			
S96T000344	124:2	Whole	0.0655	0.0713	0.0684			
S96T000345	124:3	Whole	0.0452	0.0513	0.0483			
S96T000346	124:4	Whole	0.0321	0.0307	0.0314			
S96T000347	124:5	Upper ½	0.0243	0.0461	0.0352[QC:e]			
S96T000348		Lower ½	0.0203	0.0195	0.0199			
S96T000349	124:6	Upper ½	0.0363	0.0417	0.0390			
S96T000350		Lower ½	0.0393	0.0393	0.0393			
S96T000351	124:7	Upper ½	0.0192	0.0215	0.0204			
S96T000352		Lower ½	0.0175	0.0125	0.0150[QC:e]			
S96T000353	124:8	Upper ½	0.0247	0.0250	0.0249			
S96T000354		Lower ½	0.0428	0.0496	0.0462			

Table A-21. Tank 241-U-109 Analytical Results: Total Alpha. (2 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			**μCi/g**	**μCi/g**	**μCi/g**	**μCi/g**	**%**	**Ci**
S96T000355	124:9	Upper ½	0.0476	0.0596	0.0536[QC:e]	Cont.	Cont.	Cont.
S96T000356		Lower ½	0.0870	0.0881	0.0875			
S96T000498	128:1	Whole	0.149	0.151	0.150			
S96T000499	128:2	Whole	0.0345	0.0419	0.0382[QC:e]			
S96T000500	128:3	Whole	0.0259	0.0193	0.0226[QC:e]			
S96T000501	128:4	Upper ½	0.0473	0.0348	0.0411[QC:e]			
S96T000502		Lower ½	0.0576	0.0659	0.0617			
S96T000503	128:5	Whole	0.0161	0.0135	0.0148			
S96T000504	128:6	Upper ½	0.0229	0.0286	0.0258[QC:e]			
S96T000505		Lower ½	0.0256	0.0151	0.0204[QC:e]			
S96T000506	128:7	Upper ½	0.0272	0.0210	0.0241[QC:c,e]			
S96T000507		Lower ½	0.0341	0.0324	0.0333			
S96T000508	128:8	Upper ½	0.0252	0.0224	0.0238			
S96T000509		Lower ½	0.0481	0.0613	0.0547[QC:e]			
S96T000510	128:9	Whole	0.0642	0.0480	0.0561[QC:e]			
Composites: fusion digest			**μCi/g**	**μCi/g**	**μCi/g**	**μCi/g**	**%**	**Ci**
S96T001411	123	n/a	0.0378	0.0285	0.0331[QC:e]	0.0350	4.6	102
S96T001658	124	n/a	0.0349	0.0337	0.0343			
S96T001699	128	n/a	0.0402	0.0353	0.0377			
Liquids: direct			**μCi/mL**	**μCi/mL**	**μCi/mL**	**μCi/mL**	**%**	**Ci**
S96T000280	124:3	DL	0.00107	< 9.27E-04	9.99E-04	n/a	n/a	n/a

Table A-22. Tank 241-U-109 Analytical Results: Total Beta.

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: fusion digest			μCi/g	μCi/g	μCi/g	μCi/g	%	Ci
S96T000262	123:4	Whole	92.4	57.9	75.15[QC:b,e]	126	12.1	3.69E+05
S96T000265	123:6	Lower ½	155	146	150.5			
S96T000345	124:3	Whole	108	103	105.5			
S96T000353	124:8	Upper ½	151	159	155			
S96T000499	128:2	Whole	99.6	98.7	99.15			
S96T000506	128:7	Upper ½	168	169	168.5			
Composites: fusion digest			μCi/g	μCi/g	μCi/g	μCi/g	%	Ci
S96T001411	123	n/a	107	103	105	131	10.4	3.84E+05
S96T001658	124	n/a	139	133	136			
S96T001699	128	n/a	152	150	151			

Table A-23. Tank 241-U-109 Analytical Results: Total Inorganic Carbon. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: direct			µg C/g	µg C/g	µg C/g	µg C/g	%	kg C
S96T000177	123:1	Whole	8,130	8,760	8,440	7,550	12.0	22,100
S96T000178	123:2	Whole	1,960	2,350	2,160			
S96T000179	123:3	Upper ½	957	901	929			
S96T000180		Lower ½	728	776	752			
S96T000181	123:4	Whole	4,380	4,720	4,550			
S96T000182	123:5	Whole	4,950	3,760	4,020[QC:e]			
			Triplicate	3,350				
S96T000183	123:6	Upper ½	12,700	12,500	12,600			
S96T000184		Lower ½	10,800	11,000	10,900			
S96T000185	123:7	Upper ½	10,300	11,200	10,800			
S96T000186		Lower ½	6,570	6,640	6,600			
S96T000187	123:8	Upper ½	7,870	9,650	9,270[QC:e]			
			Triplicate	10,300				
S96T000188		Lower ½	9,440	7,770	8,810			
			Triplicate	9,230				
S96T000189	123:9	A	6,050	13,200	8,160[QC:e]			
			Triplicate	5,220				
S96T000190		B	2,970	2,770	2,870			
S96T000191		C	1,610	1,570	1,590			
S96T000298	124:2	Whole	5,730	7,840	6,780[QC:e]			
S96T000299	124:3	Whole	3,640	3,260	3,450			
S96T000300	124:4	Whole	3,270	3,150	3,210			

Table A-23. Tank 241-U-109 Analytical Results: Total Inorganic Carbon. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: direct			**µg C/g**	**µg C/g**	**µg C/g**	**µg C/g**	**%**	**kg C**
S96T000301	124:5	Upper ½	7,330	7,670	7,500	Cont.	Cont.	Cont.
S96T000302		Lower ½	12,000	12,100	12,000			
S96T000303	124:6	Upper ½	16,100	14,800	15,400			
S96T000304		Lower ½	14,300	13,900	14,100			
S96T000305	124:7	Upper ½	8,030	9,140	8,580			
			Triplicate	8,570				
S96T000306		Lower ½	6,380	6,100	6,240			
S96T000307	124:8	Upper ½	10,400	11,200	10,800			
S96T000308		Lower ½	11,200	11,900	11,600			
S96T000309	124:9	Upper ½	9,920	9,270	9,600			
S96T000310		Lower ½	1,180	1,020	1,130			
			Triplicate	1,200				
S96T000423	128:1	Whole	18,000	16,400	17,200			
S96T000424	128:2	Whole	5,020	5,490	5,260			
S96T000425	128:3	Whole	2,930	2,920	2,920			
S96T000426	128:4	Upper ½	3,610	3,640	3,620			
S96T000427		Lower ½	8,930	10,400	9,660			
S96T000428	128:5	Whole	10,500	10,600	10,600			
S96T000429	128:6	Upper ½	13,300	14,400	13,800			
S96T000430		Lower ½	12,700	12,900	12,800			
S96T000431	128:7	Upper ½	10,500	11,700	11,100			
S96T000432		Lower ½	16,200	15,500	15,800			

Table A-23. Tank 241-U-109 Analytical Results: Total Inorganic Carbon. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: direct			**µg C/g**	**µg C/g**	**µg C/g**	**µg C/g**	**%**	**kg C**
S96T000433	128:8	Upper ½	9,190	9,650	9,420			
S96T000434		Lower ½	11,300	11,600	11,400			
S96T000435	128:9	Whole	741	668	704.5			
Composites: direct			**µg C/g**	**µg C/g**	**µg C/g**	**µg C/g**	**%**	**kg C**
S96T001407	123	n/a	6,480	7,700	7,090	8,340	7.8	24,400
S96T001657	124	n/a	8,930	8,520	8,720			
S96T001698	128	n/a	8,770	9,650	9,210			

Table A-24. Tank 241-U-109 Analytical Results: Total Organic Carbon. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: direct			**µg C/g**	**µg C/g**	**µg C/g**	**µg C/g**	**%**	**kg C**
S96T000177	123:1	Whole	2,750	2,630	2,690	3,600	7.8	10,500
S96T000178	123:2	Whole	2,220	2,480	2,350			
S96T000179	123:3	Upper ½	1,300	1,310	1,300			
S96T000180		Lower ½	1,090	1,170	1,130			
S96T000181	123:4	Whole	2,000	2,040	2,020			
S96T000182	123:5	Whole	2,620	2,330	2,480			
S96T000183	123:6	Upper ½	4,690	4,830	4,760			
S96T000184		Lower ½	4,080	4,210	4,140			

Table A-24. Tank 241-U-109 Analytical Results: Total Organic Carbon. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: direct			µg C/g	µg C/g	µg C/g	µg C/g	%	kg C
S96T000185	123:7	Upper ½	3,640	4,170	3,900	Cont.	Cont.	Cont.
S96T000186		Lower ½	3,140	2,590	2,860			
S96T000187	123:8	Upper ½	3,440	3,910	3,680			
S96T000188		Lower ½	3,600	4,350	3,870			
			Triplicate	3,650				
S96T000189	123:9	A	9,890	9,250	9,570			
S96T000190		B	3,400	2,820	3,110			
S96T000191		C	2,060	2,050	2,060			
S96T000298	124:2	Whole	1,290	1,680	1,480[QC:e]			
S96T000299	124:3	Whole	2,640	2,280	2,460			
S96T000300	124:4	Whole	1,550	2,170	1,860[QC:e]			
S96T000301	124:5	Upper ½	3,900	4,110	4,000			
S96T000302		Lower ½	4,600	4,550	4,580			
S96T000303	124:6	Upper ½	5,900	5,430	5,660			
S96T000304		Lower ½	6,070	6,270	6,170			
S96T000305	124:7	Upper ½	3,790	2,710	3,360[QC:e]			
			Triplicate	3,590				
S96T000306		Lower ½	2,340	2,960	2,650[QC:e]			
S96T000307	124:8	Upper ½	4,010	4,170	4960			
S96T000308		Lower ½	5,740	5,440	5,590			

Table A-24. Tank 241-U-109 Analytical Results: Total Organic Carbon. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Solids: direct			µg C/g	µg C/g	µg C/g	µg C/g	%	kg C
S96T000309	124:9	Upper ½	4,570	5,470	5,020	Cont.	Cont.	Cont.
S96T000310		Lower ½	6,070	4,930	5,310[QC:e]			
			Triplicate	4,930				
S96T000423	128:1	Whole	5,050	4,870	4,960			
S96T000424	128:2	Whole	2,500	2,670	2,580			
S96T000425	128:3	Whole	2,710	2,660	2,680			
S96T000426	128:4	Upper ½	2,680	2,610	2,640			
S96T000427		Lower ½	6,820	5,900	6,360			
S96T000428	128:5	Whole	4,270	4,460	4,360			
S96T000429	128:6	Upper ½	5,160	5,140	5,150			
S96T000430		Lower ½	5,380	5,140	5,260			
S96T000431	128:7	Upper ½	4,390	4,210	4,300[QC:e]			
S96T000432		Lower ½	5,740	5,790	5,760			
S96T000433	128:8	Upper ½	3,350	3,410	3,380			
S96T000434		Lower ½	4,820	5,120	4,970			
S96T000435	128:9	Whole	3,850	3,510	3,680			

Table A-24. Tank 241-U-109 Analytical Results: Total Organic Carbon. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)	Projected Inventory
Composites: direct			**µg C/g**	**µg C/g**	**µg C/g**	**µg C/g**	**%**	**kg C**
S96T001407	123	n/a	3,260	2,740	3,000	3,780	10.7	11,100
S96T001657	124	n/a	4,060	3,850	3,960			
S96T001698	128	n/a	4,140	4,600	4,370			
Liquids: direct			**µg C/mL**	**µg C/mL**	**µg C/mL**	**µg C/mL**	**%**	**kg C**
S96T000280	124:3	DL	2,320	2,360	2,340	2,340	n/a	n/a

Table A-25. Tank 241-U-109 Analytical Results: Weight Percent Water. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result		Duplicate		Sample Mean	Overall Mean	RSD Mean
Solids: direct			**% H_2O**	**Temperature Range (°C)**	**% H_2O**	**Temperature Range (°C)**	**% H_2O**	**% H_2O**	**%**
S96T000177[1]	123:1	Whole	21.76	35-205	20.56	35-205	21.16	23.7	13.6
S96T000178[2]	123:2	Whole	17.33	40-240	15.78	40-240	16.55		
S96T000179[2]	123:3	Upper ½	6.00	40-170	6.76	40-170	6.38		
S96T000180[2]		Lower ½	8.62	40-180	8.35	40-170	8.49		
S96T000181[2]	123:4	Whole	8.43	40-110	9.43	40-130	8.93		
S96T000182[2]	123:5	Whole	10.79	40-180	13.06	40-190	11.93		
S96T000183[1]	123:6	Upper ½	23.63	35-205	23.69	35-240	23.66		
S96T000184[1]		Lower ½	37.41	35-240	26.55	35-230	31.98[QC:e]		

Table A-25. Tank 241-U-109 Analytical Results: Weight Percent Water. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result		Duplicate		Sample Mean	Overall Mean	RSD Mean
Solids: direct			% H_2O	Temperature Range (°C)	% H_2O	Temperature Range (°C)	% H_2O	% H_2O	%
S96T000185[2]	123:7	Upper ½	19.84	40-170	19.21	40-170	19.52	Cont.	Cont.
S96T000186[2]		Lower ½	15.24	40-160	20.01	40-170	17.62		
S96T000187[2]	123:8	Upper ½	22.27	40-150	24.96	40-160	23.62		
S96T000188[2]		Lower ½	17.54	40-155	20.29	40-150	18.91		
S96T000189[2]	123:9	A	37.02	40-130	38.33	40-150	37.67		
S96T000190[2]		B	17.91	40-100	23.86	40-160	20.88		
S96T000191[1]		C	17.38	35-180	16.80	35-230	17.09		
S96T000298[1]	124:2	Whole	15.85	35-200	19.64	24-230	17.75		
S96T000299[1]	124:3	Whole	42.89	35-250	41.08	35-250	41.98[3]		
S96T000300[1]	124:4	Whole	11.69	35-210	10.33	35-180	11.01		
S96T000301[2]	124:5	Upper ½	20.73	40-180	24.35	40-180	22.54		
S96T000302[2]		Lower ½	19.66	40-180	23.16	40-160	21.41		
S96T000303[2]	124:6	Upper ½	30.97	40-170	26.65	40-170	28.81		
S96T000304[2]		Lower ½	36.39	40-170	35.57	40-170	35.98		
S96T000305[2]	124:7	Upper ½	15.78	40-170	15.98	40-160	15.88		
S96T000306[2]		Lower ½	17.25	35-160	20.84	40-160	19.05		
S96T000307[1]	124:8	Upper ½	35.18	24-200	34.01	35-240	34.59		
S96T000308[1]		Lower ½	34.90	40-200	33.06	27-210	33.98		

Table A-25. Tank 241-U-109 Analytical Results: Weight Percent Water. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result		Duplicate		Sample Mean	Overall Mean	RSD Mean
Solids: direct			% H_2O	Temperature Range (°C)	% H_2O	Temperature Range (°C)	% H_2O	% H_2O	%
S96T000309[2]	124:9	Upper ½	35.87	40-180	34.41	40-180	35.14	Cont.	Cont.
S96T000310[2]		Lower ½	44.54	40-140	39.73	40-140	43.30		
			Triplicate		45.62	40-130			
S96T000423[2]	128:1	Whole	31.04	40-160	31.75	40-160	30.01		
			Triplicate		27.24	40-170			
S96T000424[2]	128:2	Whole	25.60	40-210	15.14	40-190	19.69[QC:e]		
			Triplicate		18.33	40-180			
S96T000425[2]	128:3	Whole	15.21	40-220	12.93	40-200	14.07		
S96T000426[2]	128:4	Upper ½	19.72	40-260	17.67	40-220	18.70		
S96T000427[1]		Lower ½	47.87	24-260	45.55	22-260	46.71		
S96T000428[1]	128:5	Whole	35.97 (28.37)[4]	35-250	34.06 (26.86)[4]	24-260	35.02 (27.62)[4]		
S96T000429[2]	128:6	Upper ½	34.45	40-200	35.40	40-190	34.92		
S96T000430[2]		Lower ½	33.26	40-180	33.37	40-190	33.31		
S96T000431[2]	128:7	Upper ½	30.05	40-180	39.27	40-180	34.66		
S96T000432[2]		Lower ½	41.96	40-170	39.18	40-150	40.57		
S96T000433[2]	128:8	Upper ½	23.85	40-170	24.26	40-180	24.05		
S96T000434[2]		Lower ½	31.35	40-170	30.68	40-160	31.02		
S96T000435[2]	128:9	Whole	34.27	40-130	34.70	40-140	34.48		

Table A-25. Tank 241-U-109 Analytical Results: Weight Percent Water. (4 sheets)

Sample Number	Core: Segment	Sub-segment	Result		Duplicate		Sample Mean	Overall Mean	RSD Mean
Composites: direct			% H_2O	Temperature Range (°C)	% H_2O	Temperature Range (°C)	% H_2O	% H_2O	%
S96T001407[2]	123	n/a	18.19	40-170	21.53	40-160	19.86	25.3	12.4
S96T001657[2]	124	n/a	26.27	35-170	24.46	35-180	25.37		
S96T001698[2]	128	n/a	30.13	35-180	31.23	35-200	30.68		
Drainable Liquids: direct			% H_2O	Temperature Range (°C)	% H_2O	Temperature Range (°C)	% H_2O	% H_2O	%
S96T000280[2]	124:3	DL	53.37	40-190	53.03	40-190	53.20	n/a	n/a

Notes:

[1]Analysis performed on Perkin-Elmer™ equipment.

[2]Analysis performed on Mettler™ equipment.

[3]Due to HHF contamination, the results from this segment were not used in the mean, RSD (mean), or inventory calculations. The data are presented for informational purposes only.

[4]This sample showed a low level of HHF contamination. The corrected weight percent water results are given in parentheses (27.62%), and these values were utilized in the mean, RSD (mean), and inventory calculations.

Table A-26. Tank 241-U-109 Analytical Results: Energetics by DSC. (5 sheets)

Sample Number	Core: Segment	Sub-segment	Run	Sample Weight	Transition 1		Transition 2		Transition 3	
Solids: direct				mg	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)
S96T000177[1]	123:1	Whole	1	32.05	132.0	905.5	279.2	70.34	---	---
			2	48.71	143.3	375.9	---	---	---	---
S96T000178[2]	123:2	Whole	1	45.05	144.7	455.8	283.5	59.0	---	---
			2	49.95	143.8	317.8	283.8	73.0	---	---
S96T000179[2]	123:3	Upper ½	1	35.07	126.1	161.1	201.3	0.8	291.9	160.3
			2	35.30	115.1	91.8	198.0	4.1	288.9	121.0
S96T000180[2]		Lower ½	1	40.00	121.5	134.1	196.9	1.0	296.7	176.5
			2	22.68	106.5	300.3	197.4	2.3	298.4	179.7
S96T000181[2,3]	123:4	Whole	1	18.81	121.3	201.1	287.5	160.3	338.5	6.3
			2	26.86	116.4	192.2	191.7	9.7	288.8	140.7
S96T000182[2,4]	123:5	Whole	1	24.54	128.6	223.3	275.1	166.7	364.5	2.8
			2	38.43	139.5	273.5	276.6	98.4	326.2	2.5
S96T000184[2]	123:6	Lower ½	1	43.86	145.8	519.5	242.3	-68.7	---	---
			2	42.66	149.5	547.5	240.0	-9.8	350.0	-78.7
			3	53.19	139.3	407.5	341.9	-52.9	---	---
S96T000186[2]	123:7	Lower ½	1	24.52	110.8	476.8	284.5	94.6	---	---
			2	19.62	103.0	458.1	272.7	104.7	---	---

Table A-26. Tank 241-U-109 Analytical Results: Energetics by DSC. (5 sheets)

Sample Number	Core: Segment	Sub-segment	Run	Sample Weight	Transition 1		Transition 2		Transition 3	
Solids: direct				mg	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)
S96T000187[2]	123:8	Upper ½	1	39.74	147.4	763.0	285.5	50.2	--	--
			2	20.96	115.6	873.4	274.4	56.5	--	--
S96T000188[2]		Lower ½	1	28.40	143.6	711.9	270.5	47.6	---	---
			2	36.88	145.9	605.7	274.2	39.4	---	---
S96T000189[2]	123:9	A	1	10.99	122.0	1,973	417.3	-19.0[QC:e]	---	---
			2	11.34	123.7	2,112	413.8	-35.7[QC:e]	---	---
S96T000190[2]		B	1	9.69	99.3	1,537	294.1	623.1	--	--
			2	16.23	111.0	1,064	293.7	564.5	---	--
S96T000191[2]		C	1	21.19	128.4	529.5	297.6	602.8	---	---
			2	23.57	127.4	323.8	299.9	509.8	---	---
S96T000298[2]	124:2	Whole	1	23.22	114.8	314.9	301.4	139.4	---	---
			2	21.0	115.4	271.8	301.8	136.6	---	---
S96T000299[2]	124:3	Whole	1	23.75	123.4	529.7	274.4	64.6	---	----
			2	27.65	136.9	518.8	274.3	47.7	---	---
S96T000300[2]	124:4	Whole	1	23.03	120.2	527.9	---	---	---	---
			2	19.66	102.3	624.8	---	---	---	---
S96T000302[2]	124:5	Lower ½	1	22.14	34.7	694.0	235.7	-29.9	351.6	-185.1
			2	12.01	103.4	634.1	235.8	-26.5	351.7	-210.8

Table A-26. Tank 241-U-109 Analytical Results: Energetics by DSC. (5 sheets)

Sample Number	Core: Segment	Sub-segment	Run	Sample Weight	Transition 1		Transition 2		Transition 3	
Solids				mg	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)
S96T000303[2]	124:6	Upper ½	1	6.735	107.4	1,238	236.0	-21.4	315.9	-158.5
			2	5.490	99.6	1,153	228.0	-20.4	309.9	-171.8
S96T000304[2]		Lower ½	1	9.350	117.0	1,233	236.1	-30.0	306.0	-60.3
			2	12.55	130.4	1,502	238.1	-33.4	312.0	-63.7
S96T000306[2]	124:7	Lower ½	1	6.30	107.8	379.8	273.7	76.4	---	---
			2	20.06	111.2	548.3	219.7	2.9	273.0	106.9
S96T000308[2]	124:8	Lower ½	1	18.05	108.2	1388	273.7	53.6	---	---
			2	20.41	124.2	1138	273.5	48.9	---	---
S96T000310[2]	124:9	Lower ½	1	13.39	123.3	2012	210.1	12.3	---	---
			2	19.72	121.3	1,340	234.2	11.2	294.1	20.1
			3	15.33	117.3	1,455	236.3	36.2	---	---
S96T000423[2]	128:1	Whole	1	20.73	135.3	1,870	---	---	---	---
			2	19.34	139.4	855.6	247.5	-14.8[QC:e]	---	---
			3	21.98	137	842.2	247.5	-21.5	356.9	44.8
S96T000424[2]	128:2	Whole	1	33.43	131.4	480.6	268.3	-86.5	---	---
			2	23.34	105.3	841.6	271.4	84.6	---	---
			3	21.13	105.2	975.2	269.1	77.7	---	---

Table A-26. Tank 241-U-109 Analytical Results: Energetics by DSC. (5 sheets)

Sample Number	Core: Segment	Sub-segment	Run	Sample Weight	Transition 1		Transition 2		Transition 3	
Solids: direct				mg	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)
S96T000425[2]	128:3	Whole	1	42.08	139.3	788.1	---	---	---	---
			2	78.30	141.3	611.1	---	---	---	---
S96T000426[2]	128:4	Upper ½	1	21.40	141.9	556.7	268.5	60.8	---	---
			2	42.05	138.5	646.7	274.9	96.4	---	---
S96T000427[2]		Lower ½	1	27.91	131.3	1,599	324.4	-142.6[QC:e]		
			2	26.46	133.3	1,539	246.0	-97.3[QC:e]	---	---
S96T000428[2]	128:5	Whole	1	22.81	114.5	1,356	239.7	-8.9[QC:e]	---	---
			2	25.23	145.8	1,346	243.8	-13.8[QC:e]	---	---
S96T000430[2]	128:6	Lower ½	1	12.17	122.5	1,210	236.2	-25.1	302.1	-49.2
			2	17.85	123.8	1,519	238.2	-26.7	308.1	-50.7
S96T000432[2]	128:7	Lower ½	1	19.57	121.8	1,117	226.2	-33.1	310.0	-44.8
			2	10.85	122.6	1,302	234.2	-28.2	300.1	-51.7
S96T000434[2]	128:8	Lower ½	1	5.630	34.6	1,549	271.8	76.4	---	---
			2	8.232	105.4	1,146	228.1	-4.9	326.0	-72.5
			3	8.820	107.0	1,206	226.2	-8.7	308.1	-39.8
S96T000435[2]	128:9	Whole	1	27.34	115.3	972.6	297.6	182.1	--	---
			2	14.11	131.6	804.2	304.7	144.8	---	---

Table A-26. Tank 241-U-109 Analytical Results: Energetics by DSC. (5 sheets)

Sample Number	Core: Segment	Sub-segment	Run	Sample Weight	Transition 1		Transition 2		Transition 3	
Composites: direct				mg	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)
S96T001407[2]	123	n/a	1	25.48	114.5	679.1	285.1	57.8	395.6	-13.1
			2	27.22	131.8	688.5	288.9	30.9	393.2	-15.9
S96T001657[2,5]	124	n/a	1							
			2							
S96T001698[2,5]	128	n/a	1							
			2							
Liquids: direct				mg	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)	Peak Temp. (°C)	ΔH (J/g)
S96T000280[2]	124:3	DL	1	15.14	124.8	879.4	243.4	14.0	291.0	236.0
			2	16.61	108.1	1,002	243.0	21.4	290.5	82.4

Notes:

[1]Analysis performed on Perkin-Elmer™ equipment.

[2]Analysis performed on Mettler™ equipment.

[3]A fourth transition occurred on both runs for this sample. The first run had a peak temperature of 444.5 °C and an endothermic reaction with a ΔH of 7.3 J/g. The second run had a peak temperature of 428.3 °C and an endothermic reaction with a ΔH of 18.8 J/g.

[4]A fourth transition occurred on the second run for this sample. The peak temperature was 432 °C and the endothermic reaction had a ΔH of 24.7 J/g.

[5]Data not available.

Table A-27. Tank 241-U-109 Analytical Results: Bulk Density/Specific Gravity. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)
Solids: direct			g/mL	g/mL	g/mL	g/mL	%
S96T000207	123:1	Whole	1.85	n/a	1.85	1.67	1.6
S96T000208	123:2	Whole	1.81	n/a	1.81		
S96T000209	123:3	Upper ½	1.24	n/a	1.24		
S96T000210		Lower ½	1.30	n/a	1.30		
S96T000211	123:4	Whole	1.67	n/a	1.67		
S96T000212	123:5	Whole	1.59	n/a	1.59		
S96T000213	123:6	Upper ½	1.68	n/a	1.68		
S96T000172		Lower ½	1.75	n/a	1.75		
S96T000214	123:7	Upper ½	1.82	n/a	1.82		
S96T000173		Lower ½	1.87	n/a	1.87		
S96T000215	123:8	Upper ½	1.82	n/a	1.82		
S96T000174		Lower ½	1.84	n/a	1.84		
S96T000216	123:9	A	1.42	n/a	1.42		
S96T000175		B	---	n/a	---[1]		
S96T000176		C	1.97	n/a	1.97		
S96T000282	124:3	Whole	1.66	n/a	1.66		
S96T000283	124:4	Whole	1.62	n/a	1.62		
S96T000284	124:5	Upper ½	1.73	n/a	1.73		
S96T000285		Lower ½	1.72	n/a	1.72		
S96T000286	124:6	Upper ½	1.68	n/a	1.68		
S96T000287		Lower ½	1.66	n/a	1.66		

Table A-27. Tank 241-U-109 Analytical Results: Bulk Density/Specific Gravity. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)
Solids: direct			g/mL	g/mL	g/mL	g/mL	%
S96T000288	124:7	Upper ½	1.65	n/a	1.65	Cont.	Cont.
S96T000289		Lower ½	1.70	n/a	1.70		
S96T000290	124:8	Upper ½	1.80	n/a	1.80		
S96T000291		Lower ½	1.76	n/a	1.76		
S96T000292	124:9	Upper ½	1.68	n/a	1.68		
S96T000293		Lower ½	1.31	n/a	1.31		
S96T000410	128:1	Whole	1.68	n/a	1.68		
S96T000411	128:2	Whole	1.74	n/a	1.74		
S96T000412	128:3	Whole	1.68	n/a	1.68		
S96T000413	128:4	Upper ½	1.74	n/a	1.74		
S96T000414		Lower ½	1.63	n/a	1.63		
S96T000415	128:5	Whole	1.66	n/a	1.66		
S96T000416	128:6	Upper ½	1.67	n/a	1.67		
S96T000417		Lower ½	1.68	n/a	1.68		
S96T000418	128:7	Upper ½	1.67	n/a	1.67		
S96T000419		Lower ½	1.67	n/a	1.67		
S96T000420	128:8	Upper ½	1.66	n/a	1.66		
S96T000421		Lower ½	1.73	n/a	1.73		
S96T000422	128:9	Whole	1.44	n/a	1.44		
Composites: direct			g/mL	g/mL	g/mL	g/mL	%
S96T001379	123	n/a	1.79	n/a	n/a	1.75	1.3
S96T001656	124	n/a	1.71	n/a	n/a		
S96T001697	128	n/a	1.75	n/a	n/a		

Table A-27. Tank 241-U-109 Analytical Results: Bulk Density/Specific Gravity. (3 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean	Overall Mean	RSD (Mean)
Liquids: direct			g/mL	g/mL	g/mL	g/mL	%
S96T000280	124:3	DL	1.397	1.398	1.397	n/a	n/a

Note:

[1]The laboratory did not report any results for this subsegment.

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APPENDIX B

ANALYTICAL RESULTS OF HYDROSTATIC HEAD FLUID CONTAMINATION CHECK FOR SINGLE-SHELL TANK 241-U-109

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B.0 ANALYTICAL RESULTS OF HYDROSTATIC HEAD FLUID CONTAMINATION CHECK FOR TANK 241-U-109

B.1 INTRODUCTION AND ANALYTE TABLE DESCRIPTION

Appendix B reports the results of the HHF contamination check for the 1995/1996 push-mode core sampling and analysis event. Lithium and bromide were measured to detect any contamination of the waste samples by the HHF.For a description of the sampling event and information on sampling rationale and locations, see Section 3.0. A more detailed description of the HHF results is presented in Section 4.1.4.

Column one lists the laboratory sample identification number for which each of the two analytes was measured.

Column two specifies the core and segment from which each sample was derived.

Column three specifies the subsegment for which the analyte was measured. If adequate sample was available, the waste from a given segment was split into upper and lower halves, or divided into "quarter" segments (A, B, and C). If inadequate material was recovered to split the segment, it was analyzed as a "whole" segment. The single liquid result is identified as "DL".

The "Result" and "Duplicate" columns are self-explanatory. All values below the detection level (i.e., "nondetected") are indicated by the less than symbol, <. The "Sample Mean" column is the average of the result and duplicate values. If the result and duplicate values were both nondetected or detected, then the mean is expressed as a nondetected or detected value, respectively. The result and duplicate values, as well as the result/duplicate means, are reported in the tables exactly as found in the original laboratory data package. The means may appear to have been rounded up in some cases and rounded down in others. This is because the analytical results given in the tables may have fewer significant figures than originally reported, not because the means were incorrectly calculated.

Overall means, RSDs (mean), and projected inventories were not calculated for these two analytes because they are not inherent constituents of the tank waste.

The four QC parameters assessed on the tank 241-U-109 HHF samples were standard recoveries, spike recoveries, duplicate analyses (RPDs), and blanks. Only bromide had any QC results outside the parameters specified in the SAP (Baldwin 1996b). Two samples had low spike recoveries, and these are identified in the sample mean column of Table B-1 with a superscripted "QC:c".

Table B-1. Tank 241-U-109 Analytical Results: Bromide. (2 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean
Solids: water digest			μg/g	μg/g	μg/g
S96T000229	123:1	Whole	< 1,180	< 1,290	< 1,240
S96T000230	123:2	Whole	< 1,050	< 1,150	< 1,100
S96T000231	123:3	Upper ½	< 980	< 1,000	< 990
S96T000232		Lower ½	< 1,020	< 1,020	< 1,020
S96T000233	123:4	Whole	< 1,490	< 1,560	< 1,530
S96T000234	123:5	Whole	< 1,480	< 1,480	< 1,480
S96T000235	123:6	Upper ½	< 2,920	< 2,780	< 2,850
S96T000236		Lower ½	< 2,270	< 2,190	< 2,230
S96T000237	123:7	Upper ½	< 1,300	< 1,290	< 1,300
S96T000238		Lower ½	< 1,390	< 1,420	< 1,410
S96T000239	123:8	Upper ½	< 1,030	< 1,010	< 1,020
S96T000240		Lower ½	< 1,040	< 984	< 1,010
S96T000241	123:9	A	< 494	< 499	< 497
S96T000242		B	< 142	< 139	< 141
S96T000243		C	< 244	< 258	< 251
S96T000357	124:2	Whole	< 2,750	< 2,690	< 2,720[QC:c]
S96T000358	124:3	Whole	6,110	6,570	6,340[QC:c]
S96T000359	124:4	Whole	< 2,230	< 2,370	< 2,300
S96T000360	124:5	Upper ½	< 1,310	< 1,200	< 1,260
S96T000361		Lower ½	< 922	< 990	< 956
S96T000362	124:6	Upper ½	< 485	< 491	< 488
S96T000363		Lower ½	< 510	< 482	< 496
S96T000364	124:7	Upper ½	< 1,150	< 1,280	< 1,220
S96T000365		Lower ½	< 2,840	< 1,330	< 2,090
S96T000366	124:8	Upper ½	< 956	< 946	< 951
S96T000367		Lower ½	< 1,120	< 1,130	< 1,130
S96T000368	124:9	Upper ½	< 1,120	< 1,120	< 1,120
S96T000369		Lower ½	< 1,090	< 1,240	< 1,170
S96T000511	128:1	Whole	< 1,040	< 984	< 1,010

Table B-1. Tank 241-U-109 Analytical Results: Bromide. (2 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean
Solids: water digest			**µg/g**	**µg/g**	**µg/g**
S96T000512	128:2	Whole	< 978	< 1,020	< 999
S96T000513	128:3	Whole	< 1,460	< 1,520	< 1,490
S96T000514	128:4	Upper½	< 1,480	< 1,550	< 1,520
S96T000515		Lower ½	< 474	< 482	< 478
S96T000516	128:5	Whole	1,230	1,330	1,280
S96T000517	128:6	Upper ½	< 461	< 460	< 461
S96T000518		Lower ½	< 489	< 454	< 472
S96T000519	128:7	Upper ½	< 551	< 513	< 532
S96T000520		Lower ½	< 485	< 443	< 464
S96T000521	128:8	Upper ½	< 966	< 923	< 945
S96T000522		Lower ½	< 501	< 508	< 505
S96T000523	128:9	Whole	< 262	< 280	< 271
Composites: water digest			**µg/g**	**µg/g**	**µg/g**
S96T001412	123	n/a	< 914	< 974	< 944
S96T001659	124	n/a	< 1,020	< 928	< 974
S96T001700	128	n/a	< 1,220	< 1,230	< 1,230
Liquids: water digest			**µg/mL**	**µg/mL**	**µg/mL**
S96T000280	124:3	DL	9,100	8,920	9,010

Table B-2. Tank 241-U-109 Analytical Results: Lithium. (2 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean
Solids: fusion digest			µg/g	µg/g	µg/g
S96T000256	123:1	Whole	< 254	< 213	< 234
S96T000259	123:2	Whole	< 251	< 238	< 245
S96T000260	123:3	Upper ½	< 190	< 198	< 194
S96T000261		Lower ½	< 201	< 207	< 204
S96T000262	123:4	Whole	< 214	< 228	< 221
S96T000263	123:5	Whole	< 199	< 177	< 188
S96T000264	123:6	Upper ½	< 226	< 231	< 229
S96T000265		Lower ½	< 188	< 181	< 185
S96T000266	123:7	Upper ½	< 186	< 181	< 184
S96T000267		Lower ½	< 234	< 218	< 226
S96T000268	123:8	Upper ½	< 191	< 187	< 189
S96T000269		Lower ½	< 181	< 187	< 184
S96T000270	123:9	A	< 239	< 210	< 225
S96T000271		B	< 178	< 194	< 186
S96T000272		C	< 179	< 181	< 180
S96T000344	124:2	Whole	< 216	< 214	< 215
S96T000345	124:3	Whole	< 205	< 215	< 210
S96T000346	124:4	Whole	< 221	< 210	< 216
S96T000347	124:5	Upper ½	< 241	< 250	< 246
S96T000348		Lower ½	< 210	< 208	< 209
S96T000349	124:6	Upper ½	< 195	< 182	< 189
S96T000350		Lower ½	< 183	< 186	< 185
S96T000351	124:7	Upper ½	< 248	< 224	< 236
S96T000352		Lower ½	< 223	< 204	< 214
S96T000353	124:8	Upper ½	< 200	< 189	< 195
S96T000354		Lower ½	< 197	< 175	< 186
S96T000355	124:9	Upper ½	< 201	< 195	< 198
S96T000356		Lower ½	< 207	< 216	< 212
S96T000498	128:1	Whole	< 207	< 214	< 211

Table B-2. Tank 241-U-109 Analytical Results: Lithium. (2 sheets)

Sample Number	Core: Segment	Sub-segment	Result	Duplicate	Sample Mean
Solids: fusion digest			**µg/g**	**µg/g**	**µg/g**
S96T000499	128:2	Whole	< 194	< 207	< 201
S96T000500	128:3	Whole	< 230	< 231	< 231
S96T000501	128:4	Upper ½	< 216	< 230	< 223
S96T000502		Lower ½	< 214	< 205	< 210
S96T000503	128:5	Whole	< 206	< 196	< 201
S96T000504	128:6	Upper ½	< 218	< 197	< 208
S96T000505		Lower ½	< 223	< 221	< 222
S96T000506	128:7	Upper ½	< 220	< 221	< 221
S96T000507		Lower ½	< 188	< 215	< 202
S96T000508	128:8	Upper ½	< 208	< 205	< 207
S96T000509		Lower ½	< 227	< 238	< 233
S96T000510	128:9	Whole	< 221	< 213	< 217
Composites: fusion digest			**µg/g**	**µg/g**	**µg/g**
S96T001411	123	n/a	< 203	< 197	< 200
S96T001658	124	n/a	< 194	< 195	< 195
S96T001699	128	n/a	< 182	< 194	< 188
Liquids: direct			**µg/mL**	**µg/mL**	**µg/mL**
S96T000280	124:3	DL	< 4.010	< 4.01	< 4.01

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APPENDIX C

ANALYTICAL RESULTS FROM HISTORICAL SAMPLING EVENTS FOR SINGLE-SHELL TANK 241-U-109

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C.0 ANALYTICAL RESULTS FROM HISTORICAL SAMPLING EVENTS OF SINGLE-SHELL TANK 21-U-109

C.1 INTRODUCTION

Appendix C presents analytical results from the 1975 historical sampling event for tank 241-U-109. A description of this event was provided in Section 3.4. As explained in that section, because of the active process history of the tank, these results are not representative of the current tank contents. Thus, these data are presented for information only. Because of the lack of proper QA/QC procedures, the data presented in these tables may not be reliable and should be used with caution. Further detail regarding this sampling event can be found in the source document (Horton 1975a).

Table C-1. 1975 Supernatant Sample from Tank 241-U-109.[1,2]

Physical Data		
Component	**Lab Value**	**Lab Unit**
Density	1.24	g/mL
Water content	63.3	Weight percent
Chemical Data		
Component	**Molarity**	**Weight Percent**
Na_2CO_3	0.243	2.1
$NaNO_2$	0.628	3.5
$NaNO_3$	3.08	21.1
NaOH	1.31	2.5
$NaAlO_2$	0.342	2.3
Na_3PO_4	0.0476	0.6
Si	0.0111	2.5
Fe	8.24E-04	<1.0
Mg	4.13E-04	<1.0
Mn	8.55E-04	0.3
Pu	5.86E-05	n/a
Radiological Data		
Component	**Lab Value**	**Lab Unit**
^{137}Cs	75.42	µCi/L
$^{89/90}Sr$	3,150	µCi/L

Note:

[1]Horton (1975a)

[2]Because of the lack of proper QA/QC procedures, the data presented in these tables may not be reliable and should be used with caution.

Table C-2. 1975 Sludge Sample from Tank 241-U-109.[1,2]

Physical Data		
Component	**Lab Value**	**Lab Unit**
Bulk density	1.05	g/mL
Particle density	2.73	g/mL
Chemical Data		
Component	**Lab Value**	**Lab Unit**
H_2O	36.7	Weight percent
Al_2O_3	17.4	Weight percent
FeOOH	10	Weight percent
Na_2CO_3	2.4	Weight percent
$NaNO_2$	0.8	Weight percent
$NaNO_3$	4	Weight percent
NaOH	1	Weight percent
SiO_3	0.7	Weight percent
Na_3PO_4	21.9	Weight percent
Mg	0.03	Weight percent
Mn	0.1	Weight percent
Pu	63.3	μg/g
Radiological Data		
Component	**Lab Value**	**Lab Unit**
^{137}Cs	325.5	μCi/g
$^{89/90}Sr$	128.6	μCi/g

Note:

[1]Horton (1975a)

[2]Because of the lack of proper QA/QC procedures, the data presented in these tables may not be reliable and should be used with caution.

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